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Systematic Botany

THE prime factor for biological research is the organism itself. When one speaks of "hybrid corn," the term covers hundreds of biologically different entities; and likewise the name "Drosophila" does not apply alone to one ubiquitous species of fruit fly that can produce a host of mutations, but to scores of similar species. The biologist must be specific in his selection of his research material, because the very character or quality that absorbs his interest may be specifically limited within the species or strain of organism with which he works.

It is the function of the systematist to organize and catalogue information on relationships among organisms, particularly in the taxonomic categories of family, genus, species, etc. Upon this work all other biological endeavor depends and builds.

In order to classify correctly the present-day end products of the natural evolutionary process in any given group, it is necessary to determine as accurately as possible the number and kind of discrete biological units existent in nature. Then, on the basis of all the available evidence, a logical and utilitarian classification of these may be made. Historically, the approach of the systematist has been purely morphological, and for the present, at least, morphology remains by far his most significant tool.

Speaking for the botanist: for many decades he has, in addition, given much weight to geographical distribution, with its resultant development of isolation. More recently he has been absorbing rapidly such help as he could obtain from genetics and cytology toward the perfection of his classifications. These newer disciplines are throwing abundant light on fundamental relationships with which he must reckon if he is to sharpen his view of the biological picture. Their methods and data are often interrelevant, so that border-crossing fields, burgeoning with hybrid vigor, such as cytogenetics, geneecology, physiological genetics, cytotaxonomy, and biosystematics, are widely recognized.

In assaying relationships the primary question, as aforetime, remains: What are the relative roles of heredity and environment in developing the variation one observes? These roles are becoming clarified by reproducible experiments in which the one is changed while the other is held constant.

Out of transplant experiments in which related plants of different heredity are grown together in uniform environments have developed others in which the effects of one environmental factor at a time are tested on genetically uniform material under rigidly controlled conditions. Some of the biological variation thus examined is too minor to concern the systematist. Nevertheless, classification is now seen to be intimately dependent upon more data than morphology alone provides.

But the plant systematist's task does not begin and end with making applications from the experimental field. The descriptive phases of his work are far from over, particularly in the tropical floras of the world, where the abundance of variation is such as to continue to reveal vast numbers of entities new to science as exploration progresses. Although strides are being made, the ordering up of these floras can scarcely be completed before their constituents become adequately known. Yet in these floras, too, often lie hidden the plant resources urgently needed to augment or replace meager or depleted stocks of critical materials.

War and rumors of war have affected this field of botany in many ways. On the one hand, they have interrupted planned programs, withdrawn personnel, dried up sources of support, produced shortages, and even destroyed irreplaceable collections; but, as if in partial compensation, they have made accessible to botanists many little-known outposts of civilization, interested numbers of people in floras new to them, furthered exploration, and instigated research on new uses for the world's plant resources.

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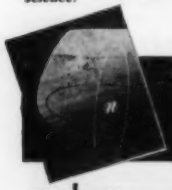

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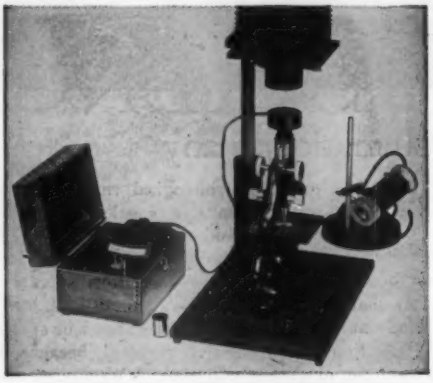

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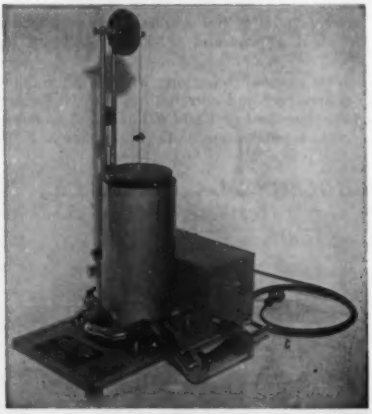

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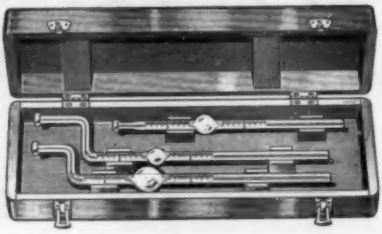

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INFORMATION ON THE EARNINGS OF SCIENTISTS included in the 1949 edition of the biographical directory *American Men of Science*[1] is most useful for the light it throws on the professional earnings of Ph.D.s and the major factors that influence their salary levels. The survey covered a large proportion of all the Ph.D.s in the natural sciences,[2] and a small proportion of non-Ph.D.s—presumably those equal to the Ph.D.s in scientific achievement.

The fact that American Men of Science with bachelor's degrees only were a highly selected group is reflected in their salaries. Their median regular annual salary was $6,450 a year at the time of the survey (in mid-1948), as compared with $5,720 a year for Ph.D.s and $5,610 a year for scientists holding master's degrees.[3] Close to half the bachelors were employed in private industry, where salaries are relatively high, whereas colleges and universities were the largest employers of Ph.D.s. Over half the American Men of Science with Ph.D.s were working at least part-time for educational institutions, and 44 per cent had no other regular employment. In many specialties, the proportion working exclusively for colleges and universities was considerably above this over-all figure (Table 1).

TABLE 1

PROPORTION OF PH.D. SCIENTISTS WORKING FOR SPECIFIED TYPES OF EMPLOYERS, BY FIELD OF SPECIALIZATION

Field of specialization	Total reporting	Education	Government	Education and government	Private industry	Foundation	Independent consultant	Education and independent consultant	Other
Total reporting	100.0	44.2	10.9	2.5	26.5	1.8	1.1	7.8	5.2
Chemistry	100.0	30.2	7.0	.8	49.1	2.1	.8	6.0	4.0
Engineering	100.0	20.1	[illegible]	1.2	43.6	.9	4.0	15.6	6.9
Physics and electronics	100.0	46.7	11.0	1.6	22.9	1.0	.8	11.4	4.6
Earth sciences	100.0	37.1	17.5	5.4	14.2	1.0	3.8	13.8	7.2
Agriculture	100.0	49.6	23.5	9.0	9.0	.6	.7	5.2	2.4
Biology	100.0	60.0	16.1	4.7	9.0	2.4	.5	4.1	3.2
Medicine	100.0	31.3	20.0	3.1	8.2	3.1	2.5	10.8	21.0
Fields related to medicine	100.0	70.1	6.8	1.1	10.4	2.2	.2	5.5	3.7
Mathematics and statistics	100.0	75.6	7.2	1.5	4.6	.3	.6	7.4	2.8
Psychology	100.0	55.1	6.3	3.1	4.0	1.1	.7	11.7	18.0
Other	100.0	37.2	12.9	1.8	28.2	3.1	1.1	9.2	6.5

Engineering offered the most notable exception to the predominance of university employment among Ph.D.s. Twice as many engineers with doctorates were working for business firms as for educational institutions. Chemistry likewise had a large proportion of Ph.D. scientists (49 per cent) in industrial employ-

[1] The survey for the 1949 edition of *American Men of Science* was conducted jointly by the National Academy of Sciences–National Research Council and the publishers of the directory. Funds and assistance were provided by the Department of Defense, through the Office of Naval Research. The questionnaires were tabulated and analyzed by the Bureau of Labor Statistics under contract with the Manpower Branch, Human Resources Division, Office of Naval Research, acting for the Department of Defense. A detailed statistical report on the fields of specialization, education, employment, and earnings of scientists in *American Men of Science* has been prepared by the Bureau of Labor Statistics, and will be published in the near future. A description of the manpower research program of the Office of Naval Research can be found in SCIENCE (112, 133 [1950]).

[2] As was indicated in SCIENCE (112, 265 [1950]), about 75 per cent of the people granted Ph.D. degrees in the natural sciences (including psychology and geography) between 1936 and 1946, and 81 per cent of those who received their doctorates in 1946–47 were included in the directory. The statistical report covers only 41,737 of the 52,600 names listed in the directory; hence, the coverage of the report is lower than that indicated by the above percentages.

[3] Regular annual salaries were reported by 82 per cent of all scientists covered by the analysis, and by 85 per cent of the Ph.D.s. Close to 40 per cent of the latter also indicated some additional professional earnings. Income information was obtained by means of check lists of income brackets. For annual salaries, the brackets began at "under $2,000 a year" and ranged up to "$10,000 or over," each intermediate bracket having a spread of $1,000.

ment. In the entire group of scientists, however, only one out of every four Ph.D.s was in private industry; only about one out of every ten worked exclusively for a government agency; and still smaller proportions worked for nonprofit foundations or were self-employed.

The median salary for all the Ph.D.s reflects in great measure both the predominance of educational employment and the relatively low salaries received by faculty members. The middle salary of the group employed exclusively in education was $4,860 a year, in contrast to a median salary of $7,070 a year in industry. Salary levels in government, although below those prevailing in industry, were also considerably above those prevailing on the campus, the median salary for Ph.D.s in government employment being $6,280 a year. The small group of scientists working for nonprofit foundations and institutes earned about the same amount as government employees. If all the educators, including those who had other work as well, had been combined into one category, the middle salary in education would have been somewhat higher. The median salary of those employed by both government agencies and educational institutions was $5,710 a year, and those who combined educational employment and consultation had a median salary of $5,570.

The tendency toward higher salaries in private industry holds true for every specialty. Even for the one exception shown in Table 2, physics and electronics, a comparison of parallel age groups shows that scientists in industry received the highest median salary in every instance. Even the lowest-paid scientists in private industry, the biologists, tended to fare

TABLE 2

MEDIAN AGES AND MEDIAN SALARIES OF THE PH.D.S IN EACH SPECIALTY BY TYPE OF EMPLOYER

Field of specialization	Scientists employed solely in: Education		Government		Industry	
	Median age*	Median salary	Median age*	Median salary	Median age*	Median salary
Total reporting	42	$4,860	42	$6,280	38	$7,070
Chemistry	39	$4,670	41	$6,290	37	$6,880
Engineering	42	5,700	42	7,400	39	8,000
Physics and electronics	42	5,040	41	7,400	38	7,350
Earth sciences	45	5,200	42	6,120	42	7,780
Agriculture	43	5,390	45	5,980	42	6,670
Biology	42	4,610	43	5,480	40	6,250
Fields related to medicine	42	5,060	42	5,930	39	6,850
Mathematics and statistics	44	4,760	41	6,830	40	7,350
Psychology	44	4,920	42	6,180	40	7,940

* These median age figures refer only to the scientists who reported salary.

TABLE 3

MEDIAN SALARIES OF PH.D. SCIENTISTS, BY TYPE OF EMPLOYER AND REGION OF EMPLOYMENT

Region of employment	All scientists*	Scientists employed solely in: Educational institutions	Private industry	Government
Total reporting	$5,720	$4,860	$7,070	$6,280
New England	$5,380	$4,730	$6,590	$5,410
Middle Atlantic	6,310	4,930	7,320	6,730
South	5,200	4,700	7,240	5,660
North Central	5,730	5,070	6,940	5,750
Mountain and Plain	4,940	4,620	6,500	5,810
Pacific	5,550	4,940	6,630	6,050

* Includes scientists working for all types of employers and all combinations of types.

better than the highest-paid of all the educators, the engineers.

There were differences in salary levels also between one specialty and another, whatever the type of employer. Engineers generally earned more than their fellow-specialists, both on the campus and off it, whereas biologists tended to fall at the bottom of the salary scale in every type of employment. Length of experience as evidenced by age undoubtedly plays a part in these salary differentials. Even more influential appears to be the dominant source of employment in the field. Engineers are in such great demand in private industry that universities must make some concession to the higher levels of pay of business firms if they are to attract and hold these specialists. In biology, on the other hand, the leaven of industrial competition is too slight to affect college salaries.

Salary differentials among types of employers, however, far outweighed regional differentials in salary levels. In every section of the country scientists employed exclusively in educational institutions tended to earn considerably less than those employed in government agencies, who in turn averaged somewhat less than the group working for business firms. Moreover, the highest median salary received by educators in any region was well below the lowest median regional salary received by scientists in government or in industry (Table 3).

The monetary advantages enjoyed by scientists in private industry appear even greater when age is taken into account. Despite their higher median earnings, the Ph.D.s in business firms tended to be younger than their fellow-specialists employed elsewhere. As would be expected, the older men normally received higher salaries than their younger colleagues, whatever the type of employment. But median salaries tended to increase more rapidly with age in private industry than in any other type of employment. Middle salaries among the men under thirty were not too far apart as between one type of employment and another. Scientists in this age group who reported

only one type of employment had a median *annual* salary of $3,900 in education, $5,050 in government, and $5,560 in private industry. In the fifty-to-fifty-four-year age group, however, the differential was great, the median salary being $9,980 in private industry as contrasted with $6,800 in government and $5,460 in educational institutions (Fig. 1).

Since the scientists in this survey were not asked to indicate their exact salaries if these reached or exceeded $10,000 a year, this report cannot compare the highest salaries among the various types of employment. What the study does show is an enormous difference in the proportion receiving $10,000 or more

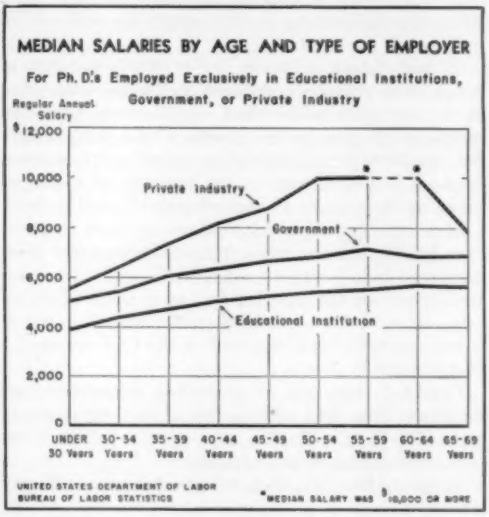

FIG. 1.

a year in private industry as compared with either government or educational employment. In private business 47 per cent of the scientists between forty-five and sixty-five earned $10,000 or more a year as opposed to 7 per cent of those in government and 4 per cent of the educators of comparable age.

Although the highest-paid scientists were found in private industry, the range of salaries was much wider in this type of employment than in either education or government, and some industrial scientists were no better off financially than their colleagues in government or education. By and large, however, the lower-paid scientists in private industry made more than the lower-paid ones in any other kind of employment. Salaries under $5,000 were reported by only 5 per cent of the Ph.D. scientists between fifty and sixty-five in industry, but by 11 per cent of those in government, and by 36 per cent of the educators.

A comparison of the annual salaries of educators

TABLE 4

ADDED PROFESSIONAL INCOME AND MEDIAN REGULAR SALARY OF PH.D.S WORKING FOR SPECIFIED TYPE OF EMPLOYERS

Type of employer	Median regular salary	Added income	
		Percentage reporting*	Median
Educational institution	$4,860	43.9	$ 810
Private industry	7,070	13.9	750
Government	6,280	12.2	†
Foundation	6,070	17.8	520
Educational institution and independent consultant	5,570	92.2	1,260
Educational institution and government	5,710	44.9	970
Educational institution and private industry	6,170	78.2	1,140
Independent consultant and government	6,720	89.6	710
Independent consultant, government, and educational institution	5,530	94.1	1,480
Independent consultant and private industry	7,710	84.1	1,060

* Percentages are based only on scientists reporting regular salary.
† Less than $500.

with those of scientists elsewhere employed must also take into account the fact that most faculty members have a nine-month year. Many people think that educators can, therefore, augment their regular salaries by such subsidiary employment as summer-school teaching and consulting to a much greater extent than is possible for scientists in government and in industry.

This supposition held true to some extent among American Men of Science. A much larger proportion of educators than of other scientists did supplement their salaries by earnings from other sources, though the extra income by no means made up for the difference in salary levels between education and other employment. Secondary professional income made only a slight contribution to the total incomes of either government employees or scientists working for business firms. Less than 15 per cent of the Ph.D. scientists in either category had earnings in addition to their salary, but nearly half the faculty members (44 per cent) had extra incomes. How little supplementary income compensated for the lower salary levels in education is seen in Table 4. For some people, earnings from consultation, teaching, or writing made a real contribution to the family budget. For the group of educators as a whole, however, even considering the dual job-holders along with the others, total professional income apparently tended to be well below the total income of scientists working in industry or government.

The Widened Lattice Interval and its Essential Role in the Behavior of Crystalline Metal[1]

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IT IS WELL RECOGNIZED that solid metals exhibit two opposed conditions: a "soft" condition which may show after thorough annealing, and a "hard" condition produced by strain (cold-work). The fact is equally familiar that these two states may pass one into the other by many gradations.

In the fully annealed, or "dead-soft," condition the x-ray diffraction lines from the metal are sharp, and the K_α doublet, if present, is fully resolved. The diffraction spectrum is that to be expected from a continuous and uniform lattice. After hardening by strain, on the other hand, the metal yields much-broadened lines that betray diminished regularity in the intervals between diffracting points, the atoms, or ions, of the crystal.

The irregular intervals of the hardened lattice may: (*a*) be due to its subdivision into small particles of normal crystal between which widened spacings occur; or (*b*) be produced, without separation into discrete particles, by widening of portions of occasional interplanar spacings, "parameter variation." There has been diversity of opinion among the numerous investigators as to which of these two causes is responsible for line broadening by cold-work, and it is possible that both may sometimes be present (*1*). Parameter variation can occur in various families of intersecting planes and, if it progresses far enough, will result in subdivision of the crystal into particles. The presence of such particles may hence constitute the extreme case of parameter variation, reached either locally or generally, as the manner and degree of distortion determined.

The two causes may thus differ only in degree; but in any case it is clear, merely from the x-ray studies alone, that in work-hardened metal, in contrast to (thoroughly) soft metal, *widened lattice intervals are present.*

The x-ray evidence is much supplemented and clarified if we make use of hydrogen and its ionization product, the proton, as probes for the exploration of metallic structure. Here relations are simplest for the Fe-type metals, which absorb endothermically, whereas complications are present in the case of palladium and the other exothermic absorbers. We therefore regard chiefly the endothermic systems (*2*).

[1] Based on material presented at the Gordon Research Conference on Chemistry and Physics of Metals, New Hampton, N. H., July 1950.

Solubilities

To begin with, we consider the metal-hydrogen solubility relations, taking as an example the well-studied instance of iron-hydrogen.

If iron of high or fairly high purity, in the state in which it is ordinarily obtained as foil or wire—that is, in somewhat cold-worked condition—is heated in hydrogen of atmospheric pressure to a temperature between 300° C and the melting point, and is allowed to come to a steady state, the quantity of hydrogen taken up by a given amount of metal is well defined.

It is reproducible within reasonable limits of error, even by different observers; it is attainable either from higher or from lower concentrations; and it increases regularly with the temperature, as is thermodynamically required for an endothermic absorption. Hence it has naturally been regarded as the true "solubility of hydrogen."

Provided, then, that we proceed in the manner just described, iron—and other metals of its (endothermic) type—Ni, Co, Cr, Cu, Pt, Ag—show a definite solubility equilibrium with hydrogen.

Suppose, however, that we proceed in a different way.

We will take iron of high purity and heat to a temperature of 800° or 1,000° C, at the same time carrying off any gas evolved with the aid of efficient pumps. When the metal, as thin foil or wire, has thus been thoroughly degassed and fully relieved of the effects of any foregoing cold-work, it approaches the state of the perfect lattice.

If we now admit hydrogen, as in the previous case, we find that the gas is not absorbed, and it is impossible to reach the solubility equilibrium. Moreover, if such thoroughly annealed and degassed iron is made cathode in an electrolytic cell, it fails to absorb, in spite of the high effective pressure at which the hydrogen is thus applied—a pressure which at usual currents is certainly equivalent to many atmospheres. As we know, less annealed iron takes up cathodic hydrogen readily and in large quantity.

We have then the fundamental fact that, whereas strained iron can establish an entirely normal solubility equilibrium with hydrogen, such a condition cannot be reached with the thoroughly annealed metal. This is established by the concordant results of several experimenters, and such evidence exists for other metals as well (*3*).

The metal-hydrogen solubility equilibrium is therefore peculiar in that the possibility of its attainment is dependent on the previous history of the metal. Diffusion of hydrogen into the material is clearly conditioned by the strained state! This does not accord with the idea that we are dealing with a solid solution, as commonly conceived, an interstitial, or even a substitutional distribution of hydrogen within the metal; for if the hydrogen were thus contained it should evidently diffuse into perfect lattice.

Elsewhere (*2*) the solubility of hydrogen in metal has been defined as "the occlusive capacity of the metal in a fully annealed condition." To agree with all the facts, this definition is in need of supplement. It should read: "The solubility of hydrogen is the occlusive capacity of the metal (at given t and p) in a fully annealed condition, *when some measure of cold-work and subjection to hydrogen have preceded full anneal (in hydrogen)*."

In other words, observance of the order of sequence —cold-work, exposure to hydrogen, full anneal (in H_2)—is necessary if this equilibrium is to be reached.

If the metal is not *somewhat* cold-worked, the process of interchange of hydrogen between gas-phase and solid will not begin; and if full annealing occurs before some hydrogen has been taken up, or when all hydrogen has been allowed to escape, the metal will revert to a dead-soft and (absorptively) wholly inert state.

All the foregoing is merely a statement of empirical facts well established for iron and some other metals. The only interpretation seems to be that the paths of diffusion and storage places of the hydrogen are not present in perfect lattice but are produced by strain.

In this connection it is illuminating to note that, at just above 400° C, the solubility of hydrogen in iron is of the order of 1 atom of hydrogen to 50,000 atoms of iron (*4*), or roughly 1 atom of hydrogen for 25,000 cells of the bcc metal. Strain has evidently not made the lattice interstices in general receptive to the solute, and diffusion and storage of hydrogen are confined to certain altered regions.

Since these altered regions, like the widened intervals shown by x-ray investigation, are present only in strained metal, it requires no bold leap to identify the two things; and the conclusion is fully borne out by the manner of evolution of hydrogen from metal, when the temperature is raised by steps.

Again taking iron as our example, let us suppose it to have been surcharged with hydrogen at room temperature—by cathodic treatment, by heating in the gas at higher temperature and subsequent cooling, or merely by exposure to the gas at room temperature when the metal is in severely cold-worked condition.

If, after any of these methods of supersaturation, the temperature is raised, say, to 440° C, and is kept constant, the gas comes off into a vacuum, at first rapidly and then more slowly, until after two hours or less evolution has very nearly ceased (*5*). On once more increasing the temperature, this time to 675° C, we find a similar effect: a renewed expulsion of gas, rapid to begin with, but quickly declining to a very low rate. And this may be repeated at several higher temperatures before the metal has been fully freed from hydrogen.

Supposing the normal or un-work-altered lattice interstices to be the storage place and the diffusion path of the hydrogen, we should expect heating to open these spaces all the way through the metal and so to cause complete escape of the gas into a good vacuum. Instead, each rise of temperature produces only a *limited* evolution—but does this even in iron, where increase of temperature results in a greater solubility; and the effect is, again, not confined to iron but probably characterizes all metal-hydrogen systems.

Clearly, the diffusion path is not the continuous route of the interstitial spaces, but some other system of voids which is only partly continuous but which extends to new regions of the metal as the latter is thermally expanded. This system can consist only of the network of work-altered and widened intervals of which we have found other evidences.

The x-ray results are entirely in accord; for, although they show pronounced line-broadening in the diffraction spectrum, as a consequence of cold-work, no displacement of the lines or maxima of diffraction are to be found in the cases of endothermically absorbing metals.

From all indications, then, occluded hydrogen does not enter the normal lattice, in these metals, but is confined to the widened intervals. With palladium, and the other exothermically absorbing metals such as Ta, Zr, Th, etc., the matter is less simple, since a secondary process occurs in which electrons are taken into the nucleus of the metal atom, causing distention of the "normal" lattice. Even here, however, the occurrence of a primary occlusion like that found in the Fe-type metals, is indicated by many facts.

In the metals of the simpler Fe-type, we may distinguish two temperature ranges:

1. *Above a rather ill-defined "recovery" temperature* (often from 300° to 400° C, sometimes perhaps lower) the opening of widened intervals in the lattice is a *reversible process*. Here the material is *elastic* to hydrogen pressure, and the network of work-altered intervals opens to a total volume determined by the hydrogen pressure, the temperature, and the specific nature of the metal. A solubility equilibrium can be reached; or, if the hydrogen is allowed to escape and the metal severely annealed, the widened intervals may be made to close up.

2. *Below the recovery range*, intervals are opened by strain but the process is irreversible. Here no solubility equilibrium can be reached, but work-opened intervals take up large quantities of hydrogen, even at room temperature, these being indeed the largest occlusions which occur (except during deposition of the metal, when the lattice is still in process of formation). Thus at 25° C, "pure" iron, rolled down to thin foil and not afterward annealed, has been found to take up some 45 relative volumes of hydrogen (*6*). This is 5.7 ml/g, as compared with the immeasurably small amount which would be obtained as the solubility at this temperature, if we were

warranted in extrapolating from 400°. It is not without interest to note that this occlusive capacity of severely strained iron, in massive condition, is some hundreds of times greater than the (activated) adsorption reported for this same metal in finely divided form.

The hydrogen thus absorbed brings about pronounced broadening of the x-ray diffraction lines, together with that other important effect of mechanical cold-working, hardening of the metal. Hence we see that the widened lattice intervals, once they have been produced by mechanical deformation, can be further extended merely by the entry of hydrogen, which thus itself has the effect of strain. There is also to be mentioned the closely related fact that occlusion of hydrogen is in its early stages self-accelerating.

Further illumination of the nature of the widened intervals is afforded by the variation of solubility with temperature.

A rough calculation, which has been given elsewhere (*2*, p. 258), shows that, although the (cubic) thermal expansion of iron uncharged with hydrogen, between 400° and 600° C, and therefore the approximate increase of normal interstitial volume, is of the order of only 4.9×10^{-5} per cent per degree, the increase in its solvent capacity for hydrogen at 1 atmosphere pressure is, in the same temperature range, of the order of 1.12 per cent per degree. The growth of the volume of the widened intervals which receive the hydrogen is accordingly more than 10^4-fold larger than that of the interstitial volume of the metal. Evidently the two volumes are relatively unconnected, and the volume of the widened spaces—shortly termed the "strain volume"—increases far more than in proportion to the other. More exact calculation, in which the volumes occupied by the atoms are taken into account, yields a qualitatively similar result.

The Widened Intervals as Rifts

Such behavior as we have just seen would not be shown by simple defects or cavities in the lattice, for the volume of these would vary in direct proportion to any homogeneous change in the volume of the containing metal. It characterizes instead a system of tears, or "rifts," in the crystal, capable of extending relatively to the lattice, and constituting a network that grows or diminishes in volume and continuity with change of hydrogen content and pressure—and with change in the volume of the surrounding unrifted lattice (when this alters in the exothermic systems of the Pd-type).

This conception of the work-altered regions, or widened lattice intervals, in strained metals as *rifts* is consistent with a great number and variety of empirical facts that have been discussed in other places (*2, 7*), and appears at present to afford the only simple explanation of a large group of phenomena embracing particularly the dissociation pressures and electrical resistances of the metal-hydrogen systems, together with their complex hystereses and overstepping effects.

Without needless repetition of these considerations, we may content ourselves here with summarizing the conclusions to which they seem to lead with cogency, and with calling attention to some of the most strikingly indicative evidence.

The Rift Network and its Characteristics

A. The behavior of the occlusion systems is inconsistent with interstitial (or substitutional!) solid solution—if we exclude the exothermic systems—but accords with the following postulates:

1. In metal with lattice already formed—
   - *a.* Occluded hydrogen is held and diffuses in a rift network (and there only, in endothermic systems).
   - *b.* The network, in such ready formed lattice, is initially produced solely by plastic deformation, being thus a characteristic of strained ("cold-worked") metal.
   - *c.* It must be partially formed before hydrogen can be absorbed. If the strain has been severe, gaseous hydrogen is taken up freely at room temperature. Into slightly strained metal gaseous hydrogen penetrates only when the rifts are enlarged by thermal expansion; but cathodic or chemically liberated hydrogen is absorbed at ordinary temperature even after slight strain.
   - *d.* Once started mechanically, the network can be enlarged either
     (1) by further mechanical strain; or
     (2) by absorption of hydrogen—which intensifies the strained condition.
   - *e.* Rifting is reversible only above a (somewhat variable) healing or recovery temperature. In the range above this, the network is elastic, a solubility equilibrium can be reached and hydrogen can keep the network open. Below the recovery range, no solubility equilibrium can be reached; but hydrogen may be absorbed in large quantities in severely strained metal.
2. During deposition of a metal—
   - *a.* Rifting may be produced, and in extreme degree, by co-deposition of hydrogen (very clear for electrodeposited metal; probable also for sputtered or evaporated films, provided the H is in highly dissociated or ionized state.)

B. Notable are the following points:

1. Rifting, being forcibly produced against the conservative forces of the lattice, changes not only the *parameters*, but also the *force-fields within the rifts*, which hence differ from those in the normal lattice interstices.
2. The stressed force-field of the rift must be highly inhomogeneous, having steep gradients which are of special effect upon atoms or ions contained within it. This probably makes the rift a place where electron exchanges occur readily.
3. The stressed field resists further changes of the kind which produced it, and so may be regarded as the chief cause of mechanical hardness.
4. The forces overcome in rift formation react upon the atoms in which they originate; and the resultant changed state of these atoms is the cause of magnetic hardness and altered atomic properties.
5. Both types of hardness are therefore dependent upon the presence of rifts; and both vanish to-

gether when the metal is heated to the temperature of rift-healing—that at which rifting becomes reversible.

6. Rifts cannot properly be regarded merely as lattice defects, since
   a. during thermal expansion they increase in greater proportion than the volume of the metal as a whole; and
   b. during volume changes of other kinds, rift volume may change in opposite sense to lattice volume.

Neither of these things is true of any other sort of flaw or void, but only of a rift—a crack that can extend or contract relatively to the containing lattice. The rift network is therefore the important structural feature of strained metal, not a chance defect; and it is the rift field, with its consequences, rather than the arrangement of the surrounding matter, which chiefly determines the behavior of metal in the cold-worked condition.

Of the evidences of opened structure, those from x-ray diffractions are direct and seemingly unquestionable, although as we have seen, a certain ambiguity as regards arrangement attaches even to these. Other evidences either as to spatial or field characters differ much in cogency; but some appear very clear, and their number and accord lend them great cumulative weight. Among the most illuminating we may mention:

1. Hysteresis of the curves of dissociation pressure in Pd-type systems, which show the narrowing, or "throttling," of the diffusion paths for hydrogen as the lattice *expands* with increasing absorption; and the subsequent opening of these paths as the lattice *contracts* when gas is withdrawn.

2. Microscopic changes in Pd-H (*8*) and Ni-H (*9*), which show, not the (submicroscopic!) rifts themselves, but structural effects such as are to be expected from rifting.

3. Magnetic changes produced by occlusion in an iron cathode (*10*), which make clear the nature of hydrogen-hardening and the fact that penetration is by special paths and not by general diffusion through the lattice.

4. Changes of electrostatic capacity and a.c.-resistance, as a result of absorption and evolution of hydrogen (*11*), which demonstrate opening and closing of structure and the ionized state of the enclosed hydrogen.

5. Certain relations between the structural patterns and the corrosive behavior of iron (*5*, *12*), from which may be deduced the existence of crystallographically determined regions of sufficiently altered chemical activity to form the sites for initial chemical attack.

Studies of the absorption of highly dissociated ("atomic") hydrogen (*13*) and of the absorption or nonabsorption of the gas according to its degree of ionization (*14*) also present facts that suggest the manner of entry of the solute; and further evidence of value would doubtless be obtained—perhaps with respect to the spatial factors, and certainly concerning manner of entry, by rift or grain face—from observations upon the rate and degree of occlusion by massive metal (foil or wire), both in the soft and in the work-hardened condition, of hydrogen in these special states. Present indications are to the effect that entry is exclusively through the rifts, even with Pd-type metals, where interstitial solution, as well as rift occlusion, is undoubtedly present.

The quality of the rifts as altered force-fields is perhaps most clearly shown by fundamental phenomena of aqueous electrochemistry. Here we have the well-established facts that:

1. Hydrogen gas is not electromotively activated when brought into contact with gold, a metal which does not absorb hydrogen, and in which rifting appears to be absent under all ordinary conditions.

2. Carbon in different forms, despite its porosity and its absorption of large quantities of hydrogen, is equally incapable of acting as "hydrogen electrode" (*15*).

3. On the other hand, *metals* that absorb hydrogen—because of its occlusion in their rifts, as we have seen to be probable—are capable of activating the gas.

The obvious explanation of all this is that *the metallic rift* must be present, and that the essential electron transfer $H \rightleftharpoons H^+ + e$ occurs with facility *only in the rifts*. The conclusion is supported by consideration of more complicated electrochemical processes, and of accompanying changes of electrical resistance in metal-hydrogen systems.

Regarding the degree of ionization of hydrogen in different metals, we have preliminary indications that seem to show marked dependence on the metal. Further information on this matter is much to be desired and is probably obtainable by methods which lie to hand.

We may summarize by saying that the widened lattice intervals are evidently rifts in the crystal lattice, produced initially by plastic deformation but capable of extension or healing as conditions are varied. The rifts are apparently the distinctive characteristic of strained metal, responsible for at least some of its special properties—mechanical, magnetic, electrochemical, and presumably chemical.

The rifts have two aspects: as widened and variable lattice intervals; and as altered force-fields, although the orientation of the rift network, set by the method of deformation which produced it, must have a modifying effect. Hardening, at least, is to a large degree directional.

Existence and nature of the rifted state are demonstrated chiefly by the comportment of the metals with hydrogen, and the continued investigation of this behavior is still one of the most promising ways of extending our understanding of the whole related field; but the rifted state has an importance which extends much beyond mere problems of gas in metal, and its further study may be expected to throw light upon many properties of the metals that are of both theoretical and practical interest (*16*).

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Technical Papers

Structure of Pan's Crystalline Trisaccharide[1]

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Recently Pan, Nicholson, and Kolachov have described the isolation in crystalline form of a nonfermentable reducing trisaccharide (*1*) produced from maltose by the action of an enzyme system from *Aspergillus niger* (*2*). Through the kindness of Dr. Pan and his associates this trisaccharide has been placed at our disposal, and we wish to report preliminary studies pointing to its constitution.

The trisaccharide (I) was partly hydrolyzed by heating 1 ml of a 1% solution together with 0.67 ml of 0.5 *N* H_2SO_4 for 1 hr in a boiling water bath. An excess of $BaCO_3$ was added, the insoluble salts were removed by filtration and washed with 1.33 ml of water (II).

Further, 10 ml of a 1% solution, 0.06 g of iodine, and 0.4 ml of 1 *M* KOH were shaken together and allowed to stand for 30 min. At this point 0.2 ml more 1 *M* KOH was added, and the mixture allowed to stand overnight at room temperature. One ml of this solution was then hydrolyzed with sulfuric acid as described above (III). I, II, and III were then compared on a paper chromatogram (*3*) with the amylose series of saccharides (IV) prepared by partial acid hydrolysis of a low molecular weight amylose, the dextran series of oligosaccharides (V) similarly prepared from dextran, and a crude isomaltose preparation containing homologous, nonfermentable or difficultly fermentable higher saccharides (VI) supplied by Edna Montgomery (*4*). The chromatogram is reproduced in Fig. 1.

From a perusal of this chromatogram, it appears that Pan's trisaccharide has a considerably slower chromatographic mobility than the trisaccharide of the amylose series, yet it is by no means as slow as the trisaccharide of the dextran series. Partial acid hydrolysis produces reducing saccharides which in all probability are isomaltose and maltose, together with glucose. Partial acid hydrolysis of the aldonic acid

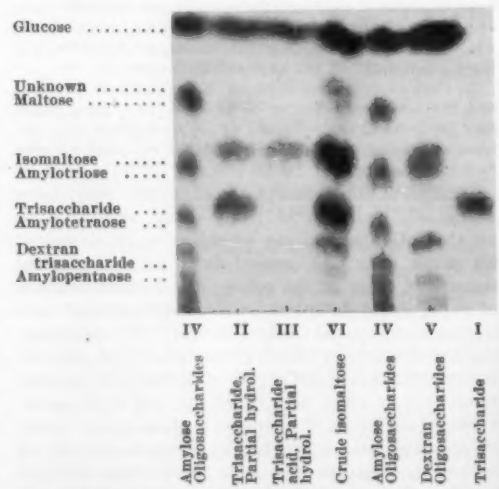

FIG. 1. Triple ascent chromatogram of Pan's trisaccharide, degradation products, and reference saccharides.

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gives isomaltose and glucose, *but no maltose*. These findings mean, first, that the trisaccharide must consist of three glucose residues united by one α-1, 4 bond and by one α-1,6 bond (the high positive rotation, $[\alpha]_D + 154°$, excludes the possibility of β-linkages); second, of the three possible structures for such a trisaccharide, the only one that could give rise to isomaltose on partial hydrolysis of the aldonic acid is that in which a glucosyl unit is joined to the sixth position in the nonreducing glucose residue of maltose; i.e., 4-[6-(α-D-glucopyranosyl)α-D-glucopyranosyl] D-glucose.

The more exact identification of the products of partial acid hydrolysis, together with confirmatory tests for other aspects of the structure, will be reported elsewhere.

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Physiological Mechanisms of Color Blindness

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Retinal processes of color-blind subjects were investigated by Motokawa's method (*1*). The electrical excitability of the eye (the reciprocal of threshold) is determined with an electrical phosphene as an index after preliminary dark adaptation of about 20 min. Stimulating currents, single constant current pulses of 100 msec in duration are applied to the eye through a pair of silver electrodes of 2×1.5 cm² in size, placed one on the forehead slightly above the eyebrow and the other on the homolateral temple of the subject. The electrical excitability of the eye is measured at varying intervals after 2 sec exposure of the eye to a preilluminating patch of 2° in visual angle. The excitability recovers in general very rapidly, becomes supernormal, and then gradually decreases to the initial level. It is, however, sometimes observed that a few humps appear in the recovery curve, especially in those obtained from color-anomalous subjects. The time course depends upon the wavelength of the light used for preillumination and upon the kind of color blindness, but little on the intensity of the preilluminating light; the latter changes only the height of the excitability curve without altering its form. Examples of excitability curves obtained from the fovea of typical dichromats as tested by Ishihara's test, as well as by Nagel's anomaloscope, are shown in Fig. 1, in which percentage increases in electrical excitability above the resting level are plotted as ordinates against time

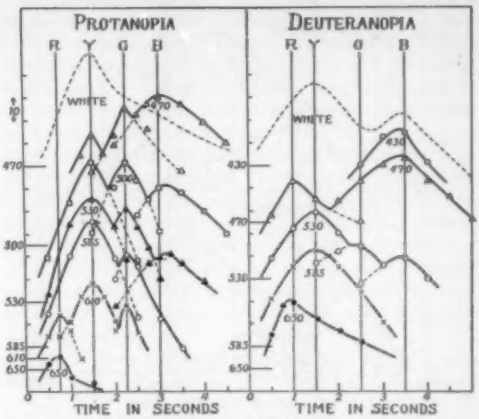

Fig. 1. Excitability curves of dichromats. Ordinates: percentage increases in electrical excitability above the resting level. Abscissae: time after the end of preillumination. Figure by each curve indicates wavelength of light used for preillumination. Zero level for each curve is indicated on the axis of ordinate.

after removal of the preilluminating light as abscissae. As can be seen in the figure, the curves generally show distinct humps, which may be classified into four groups according to their temporal location. It is very probable that these humps represent different retinal processes, but not different phases of one and the same process, because for one and the same abscissa 2 different values of threshold can be obtained, one of which belongs to the one hump, and the other to the neighboring hump, as indicated by broken lines in Fig. 1. In such cases, the subject, at a certain definite voltage, finds it very difficult, or almost impossible, to distinguish the stimulus in question from one far below the threshold, but on further decreasing the voltage, discrimination becomes easier, and thus the second threshold is reached.

The four kinds of processes may be denoted by *R*, *Y*, *G*, and *B* in the order of rapidity of processes. In color-blind subjects, any one of these processes is especially weak, e.g., the *R* process is weak in the protanope, the *G* in the deuteranope. It is another characteristic common to the two kinds of color blindness that a dominant *Y* process can be seen in the fovea. Motokawa (*2*) has provided evidence that the *Y* process, an independent process underlying a sensation of yellow, does exist in the periphery of the retina of normal and color-blind subjects, but he has not yet succeeded in proving the same process in the fovea itself of normal human subjects. The relative magnitudes of the processes are naturally different according to the wavelength of the preilluminating light. This relation is most clearly shown in the curves for spectral distribution of the four processes shown in Fig. 2, in which the ordinates represent the magnitudes of each process or the heights of each kind of hump plotted against the wavelengths of the spectral lights used for preillumination as abscissae. Fig. 2

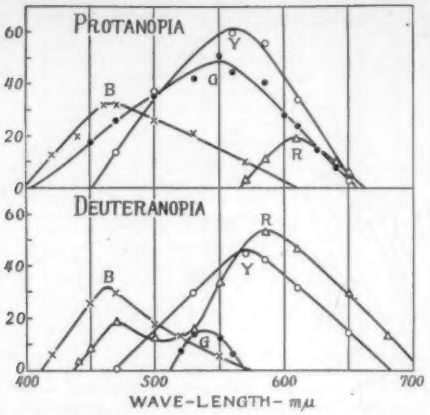

FIG. 2. Curves for spectral distribution of 4 retinal processes of dichromats.

shows that the distribution curves for the deteriorated processes, viz., the *R* in the protanope and the *G* in the deuteranope, are much lower and narrower than the other curves.

The well-known theory of Young assumes that one of three components is lacking in dichromats, but this claim obviously does not conform to our findings, (1) because there are, in reality, four components instead of three; and (2) because no component is entirely lacking, although the *R* or *G* component, in the respective color-blind types, is weaker than any others. It is to be expected from Young's theory that the sensitivity to yellow of dichromats would be deteriorated on account of the absence of the *R* or *G*, but in reality no such serious deterioration as would be expected from the theory can be demonstrated. Moreover, in rare cases such as those reported by v. Kries (*3*) and by Judd (*4*), in which one eye was color-

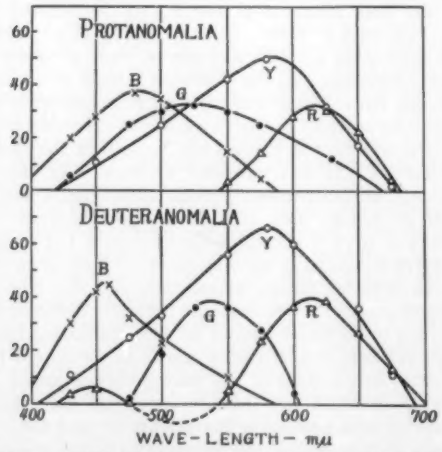

FIG. 3. Curves for spectral distribution of 4 retinal processes of anomalous trichromats.

anomalous and the other was normal, the part of the spectrum which looked yellow to the normal eye also looked yellow or yellowish to the anomalous eye. These facts which the trichromatic theory fails to interpret can easily be understood on the basis of our finding that the *Y* component is well developed in the fovea of dichromats. It is generally believed that there is a qualitative difference between anomalous trichromatism and dichromatism. In the light of our findings the difference is, however, merely quantitative (Fig. 3).

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Chromatographic Separation of Amino Sugars and Amino Acids, Using the N-(2:4-dinitrophenyl) Derivatives

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In the study of bacterial polysaccharides and mucocomplexes, the need has been found for more sensitive methods of detection and estimation of microquantities of amino sugars in the presence of amino acids, neutral sugars, and uronic acids.

The ordinary procedures of paper chromatography (*1*), investigated independently (*2*), were found to be suitable for the separation of mixtures of neutral partly methylated sugars. The amino sugars, studied by this method, separated much less readily, because of a slow rate of migration and the diffuse character of the spots—since thought to be due to the ion-exchange behavior of the papers. Some reducing amino sugars could only be observed by their reaction with alkaline silver nitrate or with ninhydrin, whereas others, mainly nonreducing amino sugar derivatives—e.g., glucosides—could only be detected by spraying the chromatogram with dilute alkaline potassium permanganate (*3*). The introduction of aniline hydrogen phthalate (*4*) as an improved general reaction for reducing sugars gave little or no coloration with free amino sugars or N-acetylated sugars. It has now been found that N-(2:4-dinitrophenyl) reducing amino sugars (*5*) did react when warmed with aniline hydrogen phthalate.

Investigation showed that amino sugars would react readily under mild conditions (viz., room temperature in the presence of sodium bicarbonate) with 2:4-dinitrofluorobenzene forming stable N-(2:4-dinitrophenyl) derivatives and that the colored nature of these compounds rendered them preeminently suitable for chromatographic analysis. A mixture of neutral sugars, a uronic acid, and DNP[2] glucosamine was

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[2] DNP = N-(2:4-dinitrophenyl).

TABLE 1

R_F VALUES

(40% butanol—10% ethanol—50% water [neutral] Whatman No. 1 filter paper downward migration)

	R_F	Silver Nitrate	Aniline Hydrogen Phthalate	Ninhydrin
3:4-dimethyl-D-mannose	0.53	+	+	–
3:4:6-trimethyl-D-mannose	.70	+	+	–
2:3:4:6-tetramethyl-D-mannose	.68	+	+	–
2:3-dimethyl-D-glucose	.51	+	+	–
2:3:4-trimethyl-D-glucose	.70	+	+	–
2:3:6-trimethyl-D-glucose	.66	+	+	–
2:3:4:6-tetramethyl-D-glucose	.85	+	+	–
1:3:4-trimethyl-D-fructose	.67	+	–	–
1:3:4:6-tetramethyl-D-fructose	.75	+	–	–
D-glucosamine hydrochloride	.1	+	–	+
N-acetyl-D-glucosamine	.24	+	–	+
N-carbobenzoxy α methyl glucosaminide	.82	–	–	–
3-methyl N-acetyl glucosamine	.34	+	–	–
4:6-dimethyl N-acetyl glucosamine	.50	+	+	–
3:4:6 trimethyl N-acetyl glucosamine	.72	+	+	–
glucosaminic acid	.02	–	–	+
α methyl 2(acetamido-) glucopyranoside	.31	–	–	+
β methyl 2-(acetamido-) glucofuranoside	.42	±	±	–
N-(2:4 dinitrophenyl) D-glucosamine	.75	+	+	–
1:3:4:6 tetracetyl DNP-D-glucosamine	.93	+	+	–
DNP glucosamine diethyl mercaptal	.89	–	–	–
tetracetyl DNP glucosamine diethyl mercaptal	.96	–	–	–
DNP glucosaminic acid	.60	–	–	–
DNP chondrosamine	.61	+	+	–
1:3:4:6-tetracetyl DNP chondrosamine	.92	+	+	–
DNP glycine	.42	–	–	–
DNP tyrosine	.77	–	–	–
DNP histidine	(i) .64	–	–	–
	(ii) .85			
DNP arginine	.65	–	–	–
DNP valine	.72	–	–	–
DNP aspartic acid	.38	–	–	–
DNP alanine	.58	–	–	–
DNP tryptophane	0.69	–	–	–

readily separated using Whatman No. 1 filter paper and neutral N-butanol (40%)—ethanol (10%)—water (50%) as the eluting agent. The yellow band could be observed directly, and on spraying the chromatogram with aniline hydrogen phthalate the other sugars were revealed and the identity of the colored band confirmed as an amino sugar derivative by its specific color change from yellow to brown.

A typical mixture separated has the following composition: glucose (0.31 mg), rhamnose (1.44 mg), arabinose (0.26 mg), 2:3:4:6 tetramethyl glucose (0.23 mg), DNP tetracetylglucosamine (0.35 mg).

The reaction with 2:4-dinitrofluorobenzene could be carried in the presence of neutral sugars. Thus a mixture containing, for example, glucosamine (2 mg), arabinose (4 mg), glucose (10 mg), and glucuronic acid (5 mg) in 1.0 ml 1% sodium bicarbonate and 1.0 ml ethanol reacted at room temperature when shaken with 2:4-dinitrofluorobenzene (0.05 ml, i.e., excess). Two drops of the resulting reaction mixture were applied to the chromatogram. The DNP amino sugar was clearly separated, the unchanged fluoro reagent moved with the solvent front, and the remaining sugars were observed by treatment with aniline hydrogen phthalate.

It was also found possible to separate DNP glucosamine from DNP chondrosamine and free amino acids, the latter being observed by their coloration with ninhydrin.

The problem of the separation of DNP amino sugars and DNP amino acids (*6*) has been investigated. This involved the determination of the R_F values of numerous DNP amino acids as summarized in Table 1. It was found that a distinct separation could be achieved between many DNP amino acids, DNP amino sugars, and free amino acids. DNP amino acids were without effect on silver nitrate solution, aniline hydrogen phthalate, or ninhydrin.

The results are being applied to the investigation of the hydrolyzates from various mucopolysaccharides.

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Proteins of Liver and Hepatoma Mitochondria

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The cytoplasmic inclusions known under the term mitochondria or chondriosomes are among the most prominent and widely distributed structures of living cells (*1*). As a result of cytological studies carried out in the past 50 years, a number of theories have arisen concerning the physiological significance of mitochondria, including the still-tenable and intriguing view that they are self-duplicating and autonomous cell organelles (*2*). Until recently, however, most ideas pertaining to their function have been based largely on conjecture.

With the advent of improvements in the technique of cell fractionation by means of differential centrifugation, permitting the isolation of intracellular components in cytologically defined states (*3*), the importance of the role played by the mitochondrion in cellular metabolism has become increasingly apparent.

TABLE 1

SEDIMENTATION CONSTANTS OF MITOCHONDRIAL PROTEINS

Preparation	Method of disintegration of mitochondria	No. experiments	Sedimentation constant*				Range of total protein concentration ($N \times 6.25$) (percentage)
			Component 1	Component 2	Component 3	Component 4	
Normal liver mitochondria	Apparatus of Milner *et al.* (*cf.* Fig. 1*A*)	4‡	3.8 (3.7–3.9)	5.1 (5.0–5.3)	7.5† (6.9–8.1)	*Ca.* 10–11†	1.4–2.3
	Sonic vibrations (*cf.* Fig. 1*B*)	3§	3.7 (3.6–3.8)	6.28 (6.24–6.33)	Absent	*Ca.* 11–13†	1.7–2.2
Hepatoma 98/15 mitochondria	Apparatus of Milner *et al.* (*cf.* Fig. 2*A*)	4‖	3.7 (3.6–3.8)	Absent	7.6† (7.2–8.1)	*Ca.* 12–15†	0.6–2.6
	Sonic vibrations (*cf.* Fig. 2*B*)	3¶	3.8 (3.8–3.9)	"	8.0† (7.4–8.4)	*Ca.* 12–13†	0.5–1.6

* Values are corrected to water and 20° and are expressed as Svedberg units.

† Polydisperse.

‡ Solvents included 0.1 *M* KCl – 0.002 *M* KH_2PO_4 – 0.016 *M* K_2HPO_4, pH 7.7; 0.1 *M* KCl – 0.05 *M* sodium veronal – 0.01 *M* veronal, pH 8.6; 0.15 *M* KCl; 0.004 *M* KH_2PO_4 – 0.032 *M* K_2HPO_4, pH 7.7; 0.1 *M* sodium veronal – 0.02 *M* veronal, pH 8.6.

§ Solvents included 0.002 *M* KH_2PO_4 – 0.016 *M* K_2HPO_4, pH 7.7; 0.1 *M* KCl – 0.002 *M* KH_2PO_4 – 0.016 *M* K_2HPO_4, pH 7.7.

‖ Solvents included 0.1 *M* KCl – 0.002 *M* KH_2PO_4 – 0.016 *M* K_2HPO_4, pH 7.7; 0.1 *M* KCl – 0.05 *M* sodium veronal – 0.01 *M* veronal, pH 8.6; 0.008 *M* KH_2PO_4 – 0.064 *M* K_2HPO_4, pH 7.7.

¶ Solvents included 0.004 *M* KH_2PO_4 – 0.032 *M* K_2HPO_4, pH 7.7; 0.1 *M* KCl – 0.002 *M* KH_2PO_4 – 0.016 *M* K_2HPO_4, pH 7.7.

Among the enzyme systems and related compounds associated with mitochondria isolated from rat or mouse liver are cytochrome oxidase (*4–6*), cytochrome c (*7, 8*), succinoxidase (*3–6*), octanoic acid oxidase (*9, 10*), oxalacetic acid oxidase (*11*), glutamic dehydrogenase (*12*), adenosinetriphosphatase (*5, 13*), triphosphopyridine nucleotide-cytochrome c reductase (*14*), diphosphopyridine nucleotide-cytochrome c reductase (*15, 16*), riboflavin (*17*), and a relatively small amount of pentose nucleic acid (*3, 5, 13*). It is thus evident that the mitochondrion is responsible for at least several of the phases of the Krebs cycle and, through its content of cytochrome oxidase and related systems, accounts for most if not all of the respiratory activity of the cell. Furthermore, certain aerobic reactions carried out by preparations of isolated mitochondria, including the synthesis of *p*-aminohippuric acid and the maintenance of high-energy phosphate bonds (*18*) lead to the suggestion that additional important synthetic reactions may take place in this cellular component.

A problem of considerable importance concerns the possible changes in biochemical properties undergone by the mitochondrion during the process of neoplasia. Along this line, a series of experiments has been initiated in which a comparison is being made of the biochemical propertities of cell fractions derived from normal C3H mouse liver and from C3H mouse hepatoma 98/15. This tumor was considered particularly suitable for such an investigation because of its high degree of differentiation and its histologic resemblance to normal liver (*19*); thus any marked differences between these two closely related tissues are probably more significant than differences of the same magnitude between a normal tissue and an anaplastic tumor. To date the results have indicated that several of the quantitative biochemical differences between the two tissues are a reflection of differences in the mitochondria (*6, 13, 16*). Similar data have been reported for the mitochondria of rat liver and rat liver tumors induced with carcinogenic azo dyes (*20*). In the latter case it was also found that alterations characteristic of tumor mitochondria were present, although to a lesser degree, in the liver mitochondria of animals fed carcinogenic azo dyes for periods insufficient to produce tumors (*21*). Furthermore, the extent of these mitochondrial alterations was roughly proportional to the carcinogenicity of the dyes fed (*21*). Thus the implication is made that mitochondria are intimately concerned in the carcinogenic process and not merely altered as a result of the carcinogenic process. These findings lend added significance to studies of the mitochondria of normal liver and hepatoma.

A consideration of certain aspects of the structure of mitochondria has recently led to a new method of study of these cellular elements. Previous cytological observations of the behavior of the isolated particles when subjected to changes in the osmotic pressure of the suspending media (*3, 22*) have provided evidence for the existence of a well-defined mitochondrial membrane. This evidence has been substantiated by electron microscopy (*23, 24*) which, in addition, has revealed the presence of internal structures of a particulate nature. In the latter respect, Claude (*22*) found that after prolonged contact with a relatively large volume of distilled water, mitochondria isolated from guinea pig liver underwent lysis, yielding particulate material of small size and a soluble fraction that in-

cluded proteins and dialyzable compounds. This finding suggested that the membranes of isolated mitochondria are capable of retaining soluble substances, including compounds of relatively low molecular weight. In fact, as noted in a recent publication (*25*), the disruption by means of intense sonic vibrations of the membranes of rat liver mitochondria resulted in the release into solution of approximately 60% of the total nitrogen. Furthermore, most of the nitrogen represented proteins that could be separated and characterized on the basis of sedimentation constants in the analytical centrifuge. The latter finding offered a unique method for the comparison of mitochondria of tumors and normal tissues and has been applied with the following results to C3H mouse liver and hepatoma 98/15.

Homogenates of perfused C3H mouse liver (10–15 livers) and of hepatoma 98/15 (30–50 small, non-necrotic hepatomas) were prepared in 0.25 *M* sucrose and were fractionated according to a procedure described previously (*6*). The mitochondria were washed twice with 0.25 *M* sucrose and were finally suspended either in distilled water or in dilute potassium phosphate buffer (0.002 *M* KH_2PO_4 – 0.016 *M* K_2HPO_4, pH 7.7). The suspensions were then either forced through a small orifice under 20,000 psi pressure at 3° in a stainless steel apparatus similar to that described by Milner *et al.* (*26*) or were subjected to sonic vibrations (9 kc) for 15 min at 3° in a Raytheon magnetostriction oscillator, Type R-22-3. After either of these procedures, the originally opaque suspensions of mitochondria were only slightly opalescent and contained few particles large enough to be seen in the phase contrast microscope. The preparations were then centrifuged at 3° for 30 min at 115,000–150,000 × *g* in the Type A or C preparative rotor of the Spinco ultracentrifuge, yielding gelatinous, transparent, reddish pellets and clear yellow supernatants, the latter containing 50–65% of the original total nitrogen. The supernatants were then dialyzed against appropriate solutions (Table 1). Ten to 20% of the nitrogen diffused through cellophane during dialysis, but most if not all of the colored substances were retained. At the same nitrogen concentration the supernatant obtained from normal liver mitochondria was much more deeply colored than that from hepatoma mitochondria.

The dialyzed supernatants were then studied in the Spinco analytical ultracentrifuge at a speed of 59,780 rpm. Figs. 1 and 2 are typical photographs showing the sedimentation of the soluble proteins obtained from the mitochondria of normal liver and of hepatoma 98/15. Table 1 summarizes the results of 14 separate experiments with the two tissues. As shown in Fig. 1*A*, most of the protein obtained from normal liver mitochondria by disintegration in the apparatus of Milner *et al.* (*26*) was represented by a slowly sedimenting, broad peak, which eventually was resolved into two distinct components (Nos. 1 and 2, Fig. 1*A*). These components were present in approximately equal concentration and were characterized by average sedimentation constants of 3.8 and 5.1 *S* (Svedberg units) (Table 1). Two other, smaller peaks (Nos. 3 and 4, Fig. 1*A*), both of which appeared to be polydisperse, sedimented at more rapid rates. The average sedimentation constant of component No. 3 was 7.5 *S*, the rather wide range shown in the table probably being due to difficulties in precisely locating the position of this peak. The sedimentation constant of component No. 4 (Fig. 1*A*) could not be determined accurately but was estimated to be approximately 10–11 *S* (Table 1). A variety of solvents was used without appreciable effect on the sedimentation constants (Table 1). Disintegration of the mitochondria in phosphate buffer rather than in water also had no effect on the results. In additional experiments it was found that the soluble proteins of mitochondria isolated from regenerating C3H mouse liver gave a sedimentation pattern identical with that obtained with normal liver mitochondria (Fig. 1*A*).

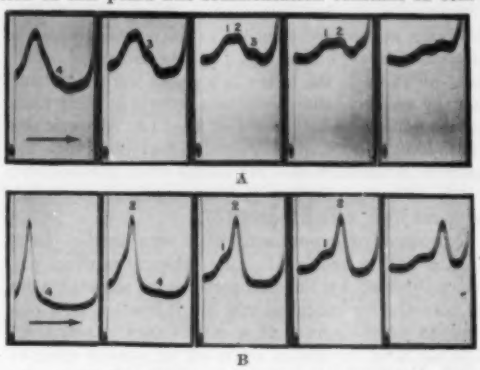

FIG. 1. Sedimentation of proteins of normal liver mitochondria. Photographs taken at 16-min intervals; speed, 59,780 rpm; solvent, 0.1 *M* KCl – 0.002 *M* KH_2PO_4 – 0.016 *M* K_2HPO_4. *A*, mitochondria disintegrated in water by apparatus of Milner *et al.*; total protein concentration, 1.5%; av temp during run, 20.6°. *B*, mitochondria disintegrated in water by sonic vibrations; total protein concentration, 1.7%; av temp during run, 21.2°.

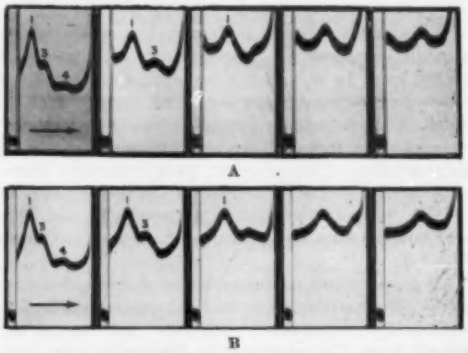

FIG. 2. Sedimentation of proteins of hepatoma mitochrondria. Photographs taken at 16-min intervals; speed 59,780 rpm; solvent, 0.1 *M* KCl – 0.002 *M* KH_2PO_4 – 0.016 *M* K_2HPO_4. *A*, mitochondria disintegrated in water by apparatus of Milner *et al.*, total protein concentration, 1.5%; av temp during run, 20.0°. *B*, mitochondria disintegrated in water by sonic vibrations; total protein concentration, 1.6%; av temp during run, 22.2°.

A distinctly different pattern was obtained when normal liver mitochondria were distintegrated by means of sonic vibrations (Fig. 1*B*). In this case most of the protein was represented by a sharp, symmetrical peak (No. 2, Fig. 1*B*), having a sedimentation constant significantly higher (Table 1) than that of component No. 2 of Fig. 1*A*. Also present were two other components, the first sedimenting slowly (No. 1, Fig. 1*B*), the second sedimenting rapidly and present in small amounts (No. 4, Fig. 1*B*). As indicated by the data of Table 1, the latter two peaks were characterized by sedimentation constants approximating those of components Nos. 1 and 4 of Fig. 1*A*. No peak corresponding to No. 3 of Fig. 1*A* was observed. The pattern obtained with C3H mouse liver mitochondria (Fig. 1*B*) was similar to that obtained previously with rat liver mitochondria (*25*).

A number of experiments have been carried out in an attempt to account for the different protein patterns obtained by the two methods of disintegration of normal liver mitochondria, but it has not been possible as yet to arrive at a satisfactory explanation. The fact that oxygen is activated by intense sonic vibrations (*27*) brings up the possibility that this or a similar chemical reaction might account for the present results. In view of previous findings (*25*) and of the fact that mitochondrial preparations show high catalase activity (*28*), it seems unlikely, however, that oxygen activation could play an important role. It should also be pointed out that, of the two methods of disintegration of liver mitochondria, only sonic vibrations yielded a component whose behavior in the analytical centrifuge suggested a homogeneous protein (component No. 2, Fig. 1*B*).

As shown in Fig. 2, three components were observed in the preparations obtained from hepatoma mitochondria, the most prominent being represented by a reasonably sharp, slowly sedimenting peak (No. 1) corresponding in sedimentation constant to component No. 1 of normal liver (Table 1). The two remaining peaks (Nos. 3 and 4, Fig. 2) were apparently polydisperse and gave sedimentation constants approximating those of components Nos. 3 and 4 of normal liver. In no instance, however, was a peak corresponding to component No. 2 of normal liver detected in the hepatoma preparations. Of additional interest is the fact that the two methods used for the disintegration of mitochondria gave essentially identical protein patterns in the case of the tumor (Fig. 2*A* and *B*), whereas the protein patterns obtained from liver mitochondria by the two methods were strikingly different.

All preparations contained material that sedimented before the centrifuge attained maximum speed. This presumably represented particles not completely cleared from the solutions by the preliminary preparative centrifugation. In addition, there was present a variable amount of material of relatively low molecular weight that did not completely clear the meniscus (*cf.* Fig. 2*A*). The rapidly sedimenting particles and the low molecular weight material accounted for a maximum of 10–30% of the total nitrogen of the individual dialyzed preparations.

It is evident from the present results that, within the limits of sensitivity of the analytical centrifuge, a qualitative difference exists between the mitochondria of hepatoma 98/15 and the mitochondria of normal C3H mouse liver. This conclusion is indicated by the fact that a prominent component of the proteins of normal liver mitochondria could not be detected in corresponding preparations obtained from hepatoma mitochondria and is further supported by the fact that liver mitochondria responded differently to the two methods of disintegration, whereas hepatoma mitochondria did not. Whether the apparent absence of component No. 2 (Fig. 1) from the tumor represents a difference of fundamental significance between this tissue and normal or regenerating liver, or represents simply the loss of some specialized function incidental to the process of neoplasia, is a problem for the future. In an attempt to answer the questions arising from the present investigation, studies of the biochemical properties of the mitochondrial proteins are being conducted, and other methods designed to provide independent verification of the results, including electrophoretic analysis and immunological tests, are being explored.

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The Existence of Hyaluronidase Substrate Factors in Microbiological Culture Media

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In the course of studies dealing with the production of hyaluronidase by bacteria, it was noted that the repeated subculture of hyaluronidase producing strains of group A *Streptococcus hemolyticus* in infusion broth (Baltimore Biological Laboratory) resulted in good enzyme titers which were maintained through successive transfers. Furthermore, a marked enhancement of hyaluronidase activity was evident when the recommended concentration of the dehydrated culture medium was doubled. In view of the reported increase of streptococcal hyaluronidase titers by the inclusion in culture media of hyaluronic acid (*1–3*), the possibility existed that mucopolysaccharide factors were retained in small quantities in the final dehydrated product, and that by increasing the concentration of the broth sufficient polysaccharide levels might be obtained which could be utilized as a substrate by the streptococci. It was of interest, therefore, to determine whether mucopolysaccharides could be isolated from microbiological culture media and, if present, to study their depolymerization by hyaluronidase. It must remain for further experiments to determine the extent and nature of the increase in hyaluronidase titers as correlated with bacterial growth or a specific enhancement factor.

Fifty-gram samples of infusion broth (B.B.L.), nutrient broth (Difco), and bacto-beef (Difco) were dissolved in 200 ml of distilled water. The concentrated broths were treated with 10% sodium acetate and 2 volumes of 95% ethyl alcohol. A precipitate formed which was recovered by centrifugation. The precipitate was dissolved in as little water as possible, the insoluble particles were centrifuged off, and the supernatant was dialyzed against running tap water for 24–48 hr and freeze-dried. The yields of the isolates in mg were as follows: infusion broth, 500; nutrient broth, 200; and bacto-beef, 90.

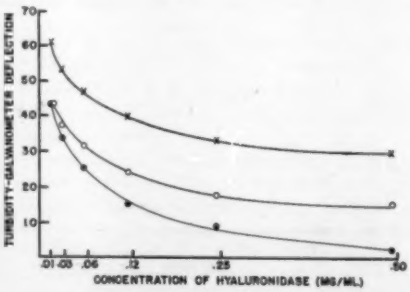

FIG. 1. The depolymerization of polysaccharide substrates by bovine testicular hyaluronidase. •——• = bacto-beef; ○——○ = infusion broth; ×——× = nutrient broth. Each system consisted of 0.5 ml of 3.0 mg/ml substrate and 0.5 ml of various dilutions of hyaluronidase. Incubated 30 min at 37° C. Reaction stopped and turbidity developed by addition of 3 ml of 0.5 *M* acetate buffer, pH 4.2, and 1 ml of 1:10 acidified horse serum, pH 4.2. Read in a Klett-Summerson colorimeter; red filter No. 66.

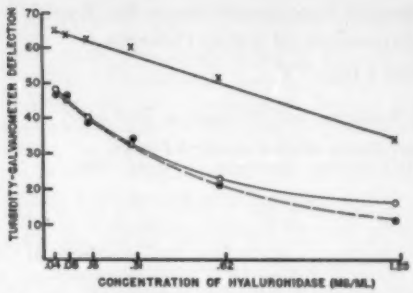

FIG. 2. The depolymerization of polysaccharide substrates by *S. hemolyticus* hyaluronidase. •——• = bacto-beef; ○——○ = nutrient broth; ×——× = infusion broth (see Fig. 1).

The depolymerization of the culture medium isolates by bovine testicular and *S. hemolyticus* hyaluronidase was measured turbidimetrically by a method described in a previous communication (*4*). The testicular hyaluronidase was prepared by essentially the method of Madinaveitia (*5*) and contained 1,400 turbidity reducing units per mg nitrogen. A crude group A *S. hemolyticus* enzyme preparation was employed and assayed 350 turbidity reducing units per mg nitrogen.

The isolated materials gave strong Molisch tests in dilutions ranging from 1:5000 to 1:20,000. Reducing substances were not present, as shown by negative Fehling's and Benedict's tests. Total sulfur as determined by the Carius method was as follows: infusion broth, 0.86%; nutrient broth, 1.77%; bacto-beef, 4.89%.[1]

The effect of testicular hyaluronidase on the depolymerization of the polysaccharide substrates is illustrated in Fig. 1. Although a difference in residual turbidities of the substrate occurred with the same enzyme dilutions, the curves produced were all on the same order. Heat-inactivated enzyme (60° C for 1 hr) did not reduce the initial turbidity of the substrates.

The depolymerization of the three substrate factors by streptococcus hyaluronidase is seen in Fig. 2. Since the bacterial hyaluronidase preparation did not possess the same degree of purification as the testicular enzyme, higher concentrations were necessary to obtain comparable reduction of the substrates. As previously reported for testicular hyaluronidase, heat-inactivated streptococcus hyaluronidase did not depolymerize any one of the three polysaccharides tested in the present study.

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[1] I am indebted to Thomas R. McCrea for these data.

A Simple Laboratory Setup for Rapid Measurement of β-Ray Dosages above 1 rep/sec[1]

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This apparatus was assembled for the purpose of obtaining absolute dosage measurements on high flux β-ray applicators of the type used in superficial radiation therapy. Ionization current measurements were previously made, using a null method with a Lindemann Electrometer as an indicator. This method was rather time-consuming, taking approximately 6 hr for a complete calibration, whereas the present setup requires about 1 hr for the same measurements, with only a slight decrease in accuracy at levels measured.

The measuring group consists of an extrapolation ionization chamber similar to that devised by Failla (*1*), a micro-microammeter, a regulated power supply, a switching apparatus, and a recording potentiometer.

The ionization chamber (Fig. 1) is a parallel plate type with a movable top plate. The top plate is a disk of 3/16-in. lucite and the bottom plate a disk of 1-in. thick lucite, lucite being chosen because of its similarity to tissue in density and to some extent in electron density. The plates are made conducting by a coating of Alkadag. On the surface of the bottom plate, the collecting electrode is separated from the guard ring by a thin circular scratch made in the Alkadag coating. The collecting electrode is 3.9 mm in diameter as measured by a micrometer microscope. The top plate can be designed for any specific β-applicator, so that the applicator may be set into it above the collecting electrode, thus radiating into the collecting volume through a thin sheet of pliofilm or 1 mm, 2 mm, etc., of lucite. The top plate is fastened to a lucite rim, which is supported by 3 micrometers spaced 120° apart. Adjustment of these micrometers allows the top plate to be moved parallel to the bottom plate through an accurately known distance. Connection is made to the collecting electrode by means of a thin pencil lead running through the bottom plate and terminating in a metal disk on the bottom. A spring-loaded point contact connects this metal disk to an amphenol lead-through type connector.

The ionization current is conducted through RG-58U cable to a Beckmann RGX-2 micro-microammeter. This instrument will measure currents greater than 1×10^{-14} amp. The micro-microammeter is mounted in the same cabinet with a voltage-regulated power supply for the ionization chamber collecting voltage. This power supply embodies a voltage takeoff from an adjustable potentiometer across a VR-150 tube, a polarity reversing switch, and a switch

FIG. 1. Extrapolation ionization chamber.

to ground the output. The micro-microammeter reading is recorded on a 0–10 mv Brown Electronic strip chart recorder.

In making readings, the micrometers are set to zero[2]

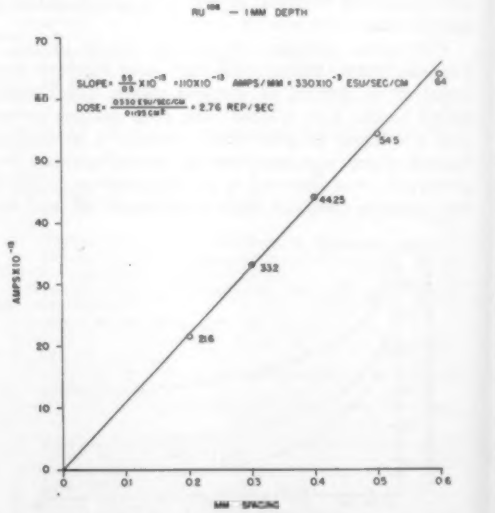

FIG. 2. Sample ionization current vs. plate spacing curve obtained using a Ru^{106} source at 1-mm depth in a lucite phantom. Calculation of radiation dose in rep/sec for this curve is shown.

[1] Work performed under Contract #W-31-109-eng-78 between Western Reserve University and the U. S. Atomic Energy Commission.

[2] Obtaining an exact zero spacing is not important, since the data to be obtained from the measurements are merely the changes in ion currents for known changes in collecting volume in the extrapolation range; that is, the range where the ion current is proportional to the chamber volume. These data are then the slopes of the extrapolation curves.

with the two plates in contact. Spacing can then be adjusted by means of the micrometers to the desired value. Collecting voltage is applied to the top plate, and for plate spacing of .5 mm or less it was found that the knee of the ionization current vs. voltage curve falls somewhat below 10 v and that the plateau extends from this point to over 350 v. In view of this, an operation point of about 40 v was chosen as appropriate for the measurements to be made.

For the dose at any one depth, readings of the ionization current are plotted vs. mm of plate spacing. This curve is essentially a straight line below .5 mm of plate spacing (Fig. 2). The slope of this line can be converted to the units of esu's of charge transferred per mm of plate spacing, and if this quantity is divided by the area of the collecting electrode as measured by the traveling microscope, a roentgen equivalent dose is obtained. The plate spacing can be adjusted by turning the micrometers to new values, and a current reading is obtained in the time needed to make a stable curve on the Brown Recorder.

The instrument shows good stability provided it is shielded by a grounded metal case, the insulated spacing between the guard ring and the collecting electrode is kept clean, and the input capacitance of the micro-microammeter is not changed. Since the micro-micro-ammeter is a current-measuring rather than a charge-measuring instrument, the actual value of input capacitance can be neglected, and a change of input capacitance will interfere only while it is taking place, the instrument again recording the true value of ionization current as soon as the input capacitance is stable.

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Crystalline Fradicin

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Swart *et al.* (*1, 2*) have reported the presence of an antifungal agent, fradicin, in neomycin fermentation liquors. This is to describe briefly a crystalline agent, presumably fradicin, which is produced by *Streptomyces fradiae*.

The most highly purified crystalline products are light greenish-yellow. They do not show a sharp mp, but darken without definite melting between about 180° to 300° C. The solubility is less than 0.05 mg/ml in methanol, ethanol, and water, but it is greater in dioxane and in chlorinated hydrocarbon solvents such as ethylene dichloride. Fradicin also dissolves fairly readily in propylene glycol; it is practically insoluble in petroleum ether, cyclohexane, and xylene.

[1] The authors wish to acknowledge the work of O. G. Wegrich for the pathogenic fungal tests, that of J. N. Spencer for the toxicity and irritation tests, and that of J. C. Carr for microchemical analyses. The criticism of S. A. Waksman on the fungal sensitivity data is also gratefully acknowledged.

Microanalytical data indicate a tentative empirical formula of $C_{30}H_{34}N_4O_4$. *Anal.* Calcd: C, 70.01; H, 6.67; N, 10.88. Found: C, 70.29; H, 6.59; N, 10.86. This differs from actidione both chemically (*3*) and microbiologically (*2*). Neutral equivalents of 498 and 514 were obtained by two methods (*4, 5*). A molecular weight in the range of 500 was found by the Barger micro method, using dioxane. The molecular weight calculated from the empirical formula is 514.6.

Fradicin is a weak base, which forms a hydrochloride obtained as needles. The $[\alpha]_D^{25}$ of the base is about + 65° (*c* 1.0, 1,4-dioxane). Micro Zeisel analyses of the base showed 11.95% alkoxyl, probably methoxyl (Calcd: 2 CH_3O, 12.04). Alkali fusion yielded a volatile product which gave positive pine splint and Ehrlich's tests for a pyrrol. Fig. 1 shows the ultraviolet absorption spectrum of crystalline fradicin in ethanol.

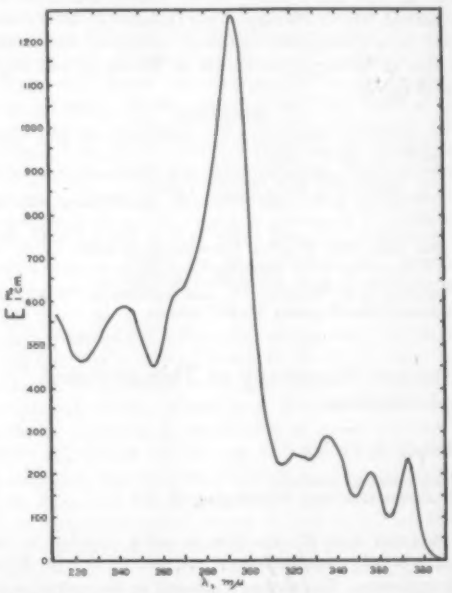

FIG. 1. Ultraviolet absorption spectrum of fradicin in ethanol.

Antifungal activity is strong at pH 7.0 and higher, but below this activity is greatly reduced. In a phenol red broth[2] at pH 7.3, activity has been demonstrated against several yeasts, including a strain of *Saccharomyces cerevisiae*, at about 0.1–0.15 μg/ml. Activity was poor against bacteria. These findings agree qualitatively with those of Swart *et al.* (*2*) for the amorphous material.

In tests using agar dilution plates[3] at pH 7.3 with 9-day incubation, inhibition was demonstrated against

[2] Difco phenol red broth base + 1% glucose + 0.1% yeast extract (Difco) + 0.1% beef extract (Difco), pH 7.3.

[3] Agar composition: peptone 1.0%, dextrose 4.0%, agar 2.0%, pH 7.3, except for *H. capsulatum*, which was studied in Campbell's medium (*6*).

some pathogenic fungi in the range of 1–10 μg/ml. Examples are given in Table 1.

TABLE 1

INHIBITION RANGE OF FRADICIN AGAINST SEVERAL PATHOGENIC FUNGI

Organism	Effective inhibition range* (μg/ml)
Candida albicans	2–4
Cryptococcus neoformans	2–4
Microsporium canis	1–3
Trichophyton mentagrophytes	3–5
Microsporium gypseum	3–10
Histoplasma capsulatum (yeast phase)	1–3

* Readings were made after 9 days' incubation.

Acute toxicity tests in mice have shown that by intraperitoneal injection, the LD_{50} was approximately 4 mg/kg. Acute oral mouse toxicity by single dose was in this same range. Some kidney ischemia was observed. Skin tests employing rabbits (*7*) have shown that, in a hydrophilic ointment, irritation was considerable at 500 μg/g, moderate at 100 μg/g, and slight at 50 μg/g.

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Electron Microscopy of Thin-sectioned Spirostomum

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A great deal of attention is being devoted to the study of ultramicroscopic structures in several kinds of organisms. The author's interest in the morphology of protozoa suggested the possibility of applying electron microscopy to the heterotrichous ciliate *Spirostomum ambiguum*. Accordingly, the microsectioning method developed at the National Bureau of Standards by Newman, Borysko, and Swerdlow (*1*) was modified for *Spirostomum*. Specimens were prepared for study as follows: Live animals were concentrated in centrifuge tubes, fixed in Bouin's or Navashin's fluid, dehydrated through a dioxan series, infiltrated, embedded, sectioned according to the method cited (*1*), and studied with the 50-kv, RCA-type EMU electron microscope. Some sections were shadowed with chromium. Figs. 1 and 2 illustrate typical results obtained when specimens were prepared in the manner described.

In Fig. 1 some of the numerous particles in the

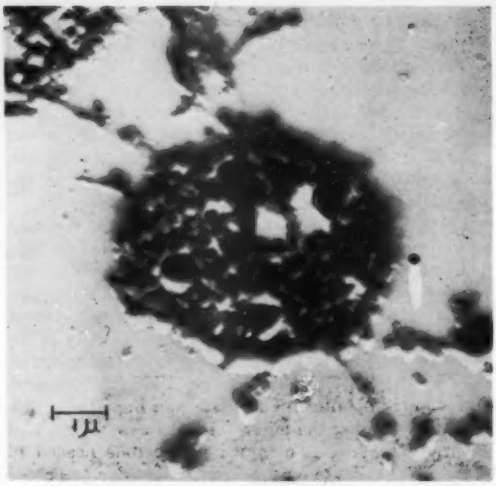

FIG. 1. Macronucleus. Chromium-shadowed (4 : 1), × 7800.

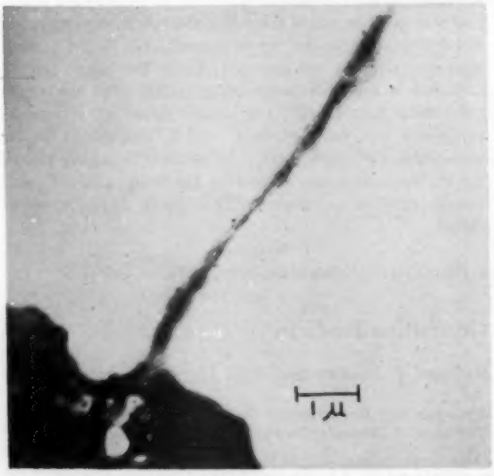

FIG. 2. Chromium-shadowed cilium, × 9000.

macronucleus are oval and others are globular in shape. Their diameters may be estimated in comparison with the shadowed particle of polystyrene latex[1] that appears in the right-central region of the figure. In making this comparison it should be remembered that the polystyrene particle was superimposed above the collodion substrate, whereas the macronuclear particles were partially imbedded in the substrate. In the macronucleus of *Spirostomum*, by suitable methods, one may discern "granular" material which gives a positive response to the Feulgen reaction; this may be a clue to the nature of the oval and globular particles shown in Fig. 1.

Fig. 2 reveals that locomotory cilia are composed

[1] Dow Chemical Co., Lot 580 G, diam approx 2600 A.

of compact bundles of fibrils. This finding is comparable to the observation reported by Jakus and Hall (*2*), who found "ultramicroscopic fibrils" in the cilia of *Paramecium*. The cilia of *Paramecium* and *Spirostomum* may be regarded as having a complex type of organization, perhaps approaching that which characterizes contractile elements of more highly specialized organisms.

The accompanying figures and numerous original micrographs indicate that the methods mentioned above may be applied to the study of protozoa. Fine detail which has not been resolved by ordinary light microscopy has been photographed from sections prepared as indicated here. A more detailed account of this work will be published elsewhere.

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A Comparison of the Number of Circulating Blood Cells in Different Parts of the Circulatory System[1]

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Conflicting statements have appeared in recent literature concerning the differences in the number of circulating blood elements in heart and peripheral blood, Roofe *et al.* (*1*), Quimby, Saxon, and Goff (*2*), and Law and Heston (*3*) have shown what they consider to be significant differences in the blood count of different parts of the circulatory system of guinea pigs, rats, and albino mice, respectively. Nevertheless, Nichols and Miller (*4*) reported no significant differences in either erythrocyte or leucocyte counts done on heart and peripheral blood of rats.

Several investigators have found that anesthesia exerts an influence upon the number of circulating blood cells. Hahn, Bale, and Bonner (*5*) reported that 30% of the normal amount of circulating cells of dogs are found in the spleen after sodium pentobarbital (Nembutal) anesthesia, and that spleens removed under Nembutal anesthesia were four times the size of those removed under ether. Similarly, Hausner, Essex, and Mann (*6*) found that anesthesia with barbituric acid derivatives produces an enlargement of the spleen, with a subsequent decrease in the number of circulating erythrocytes. Ether anesthesia has an opposite effect, producing constriction of the spleen and an increase in the number of erythrocytes found in the blood stream. In male cats, Nembutal causes a 10% increase in plasma volume (*7*). The animals of Nichols and Miller (*4*) were either anesthetized with ether or stunned by a blow on the head in order to obtain heart blood. One author (*1*) administered anesthesia after taking the peripheral counts and before doing the heart counts.

Because of the contradictory reports of these several authors, and because various techniques were followed, some of which have been shown to influence the number of erythrocytes in central and peripheral parts of the vascular system, we judged it profitable to review the problem, avoiding the use of anesthesia. It is the purpose of this paper to report our studies on the number of erythrocytes and leucocytes in heart, venous, and peripheral blood in unanesthetized dogs.

Twenty female and 12 male mongrel dogs were used in this study. All animals were fasted for 12 hr before blood was drawn. Without anesthesia and with a minimum amount of struggle the dogs were fastened in a supine position to an animal board, and blood was drawn in the following manner: (1) Peripheral blood was obtained by carefully removing the hair from an area of the ear and then nicking the ear with a sharp razor blade. Counts were made in the standard manner, using Thoma pipettes certified by the National Bureau of Standards and hemocytometers with improved Neubauer rulings. (2) Venous blood was obtained by inserting a 20-gauge needle, with as little trauma as possible, into the large vein just above the lateral malleolus. The vein was distended by pressure upon the femoral vessels. The needles were previously coated with a solution composed of 2 parts of xylol and 1 part Dri-film 9987.[2] Thoma pipettes were filled with blood as it flowed freely from the hub of the needle. Smears for differential counts were also made from this freely flowing blood. Some of the blood was collected in oxalated tubes and placed in Wintrobe hematocrit tubes. Hematocrit determinations were made by centrifuging these tubes at 2,500 rpm for 30 min. (3) Heart blood was obtained during heart puncture by inserting an 18-gauge needle, also treated with xylol and Dri-film, into the thorax through the tenth intercostal space just to the left of the mid-line. In a similar manner to the method used for venous blood, blood was obtained from, presumably, the left ventricle. It was assumed that vigorously spurting blood indicated that the needle was in the ventricle.

Erythrocyte counts made upon peripheral blood ranged from 5,320,000 to 7,840,000 cells/mm^3, with the exception of one animal that had a count of 3,540,000 cells/mm^3. This animal appeared to be in excellent condition, and the anemia could not be anticipated from its external physical appearance. Although the counts of this animal will not be included in the following ranges for erythrocyte counts, it will be included in the statistical analysis reported in Tables 1 and 2. Venous blood erythrocyte content ranged from 5,100,000 cells/mm^3 to 8,330,000 cells/mm^3. That of the heart blood ranged from 5,170,000 to 8,040,000 cells/mm^3.

[1] Done in accordance with a contract between the Office of the Surgeon General, U. S. Army, and the University of Kansas.

[2] The Dri-film was obtained from the General Electric Co., Schenectady, N. Y.

The leucocyte counts for all three types of blood fell within the limits of 5,000–20,000 cells/mm³, except for peripheral blood, in which one count went as high as 27,500 cells/mm³. The results are summarized in Table 1.

The average for the hematocrit determinations on venous blood was 43.8% and that done on heart blood was 42.9%.

The significant differences of the various counts in regard to each other were determined statistically by the Student t formula.[3] In order to be significant for the number of cases employed, t should be 1.65 or greater.

TABLE 1

Source of blood	Average and standard deviation	Coefficient of variation and probable error
	Red cells (in millions)	
Peripheral	6.653 ± 0.953	14.33 ± 1.27
Venous	6.693 ± 0.964	13.79 ± 1.18
Heart	6.426 ± 0.871	13.55 ± 1.18
	White cells (in thousands)	
Peripheral	15.39 ± 4.12	26.78 ± 3.60
Venous	13.12 ± 3.16	24.05 ± 3.06
Heart	14.44 ± 4.64	32.10 ± 5.15
	Lymphocytes (%)	
Peripheral	26.24 ± 9.30	35.44 ± 3.51
Venous	20.75 ± 15.50	74.69 ± 9.59
Heart	23.73 ± 9.74	41.04 ± 4.15
	Polymorphonuclear (%)	
Peripheral	69.27 ± 10.30	14.88 ± 1.34
Venous	69.77 ± 14.10	20.57 ± 1.96
Heart	71.03 ± 11.10	15.62 ± 1.42

The averages for the erythrocyte counts are slightly lower than those reported by Wintrobe (*8*) and in a survey of several hundred counts done by a good number of investigators (*9*). The leucocyte count averages determined by us are slightly higher than those reported in this survey. However, the ranges for erythrocyte and leucocyte counts fit within the ranges elicited. The wide range in leucocyte counts is not significant, since normal animals (dogs) may show as much as 100% variability (*9*). The percentage of polymorphonuclear cells in our animals agrees with the figures reported in the survey of Scarborough (*9*), but we found the total lymphocyte count of peripheral blood to be 6% above the reported average. This increase may possibly be due to the effects of the emotional stress of being bound down. Although most of the animals submitted to restraint without much struggle, a few animals did make efforts to free themselves. These animals soon became quiescent, however, and were then allowed to rest for a short period before the counts were taken. Emotional stimuli do result in a lymphocytosis (*10, 11*).

TABLE 2

	t
Erythrocytes	
Peripheral-venous	0.16
Peripheral-heart	0.95
Venous-heart	1.19
Leucocytes	
Peripheral-venous	0.708
Peripheral-heart	0.255
Venous-heart	0.400
Polymorphonuclears	
Peripheral-venous	0.046
Peripheral-heart	0.195
Venous-heart	0.114
Lymphocytes	
Peripheral-venous	0.510
Peripheral-heart	0.315
Venous-heart	0.276

Previous investigators have not fully explained their methods of drawing heart blood, and it seems possible that there may be some error in counts resulting from the settling and adherence of cells if the cells are drawn up into a syringe before being counted. Our method of drawing blood with silicone-treated needles prevents clotting and adherence of the cells to the needle, and settling of the cells was prevented by taking the blood as it flowed freely from the hub of the needle. This method simulates as closely as possible the procurement of the actual number of cells circulating in the blood vessels.

In dogs, we found no significant differences between heart, venous, and peripheral blood with regard to the total number either of erythrocytes or of leucocytes per unit volume. However, studies in progress on rats may reveal that certain species do possess different numbers of cells, particularly leucocytes, in heart and peripheral blood.

[3] $t = (M_1 - M_2) / \sqrt{\left[\frac{\Sigma d_1^2 + \Sigma d_2^2}{(N_1 + N_2) - 2}\right]\left[\frac{1}{N_1} + \frac{1}{N_2}\right]}$, where M = mean, N = number of cases, and d = difference from mean.

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Comments and Communications

Stress Indicators

In the third paragraph of their brief reply to my comments and those of Calkins (*Science*, **112**, 476 [1950]), Dearborn, Johnston, and Carmichael miss the point I was making. That very *essence* of stress which they refer to is a matter of linguistic analysis. In English there happen to be four structurally significant levels of stress (four stress phonemes, as we say—though perhaps the term is too "elegant"!), four levels of pitch, and three ways of terminating phrases—i.e., three terminal junctures. In our work at the Foreign Service Institute training language-and-area specialists, we have found no difficulty in devising symbols to denote all these things and in getting students to understand the symbols. Thus, we may write the sentence *How do they stŭdy?* in several ways:

(1) ²Hów dŏ thèy ³stúd$\breve{y}$¹#
(2) ²Hów dŏ ³théy stúd$\breve{y}$¹#
(3) ²Hów ³dó thèy stúd$\breve{y}$¹#
(4) ³Hów dŏ thèy stúd$\breve{y}$¹#
(5) ²Hów dŏ thèy stúd$\breve{y}$||
(6) ³Hów ²dŏ thèy stúd$\breve{y}$||
(7) ²Hów dŏ thèy ⁴stúd$\breve{y}$¹#
etc. etc

(1) is the ordinary question: medial pitch /²/ at the beginning, extending through *they*, high pitch /³/ on the first syllable of *study*, falling to low pitch /¹/ and ending in silence /#/; *stu-* has the primary stress /ˊ/, *how* the secondary /ˆ/, *they* tertiary /ˋ/ and *do* and *-dy* weak stress /˘/. In (2) the primary stress is shifted, and with it the high pitch, to *they*. In (3) *do* has primary stress and high pitch. In (4) it is *how* that has primary stress and high pitch. In (5) we have the echo question, all on high pitch, with a rise at the very end /||/. In (6) we have a way of asking the ordinary question that is usual in British speech; high pitch on *how*, but only secondary stress, while the rest of the sentence has medial pitch to the end, with a slight rise. In (7) we illustrate the first of a series of six repetitions of (1)–(6), but with highest pitch /⁴/ instead of high, as in excitement or for emphasis.

The symbols we use may not be the most practical for general use, but any system of punctuation, special type, etc., had better be based on such a controlled and tested analysis if it is to accomplish anything.

Of course, I agree with Dearborn *et al.* that Calkins is quite wrong in his objection to the use of indicative devices. Language is a system of communication, as they say. Writing (or printing) is a secondary symbol system based on language; the better we make the writing system, the better we communicate.

George L. Trager

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Washington, D. C.

Life Behind the Iron Curtain

The letter from Nathaniel Kleitman in your October 20 issue interests me greatly because of a document recently received from the Charles University in Prague. This concerns the same question of academic freedom and the "Big Lie." It is signed by the rectors of six Czechoslovakian universities and technical schools and is printed impressively in two colors. The text of the document follows:

We, the leading workers of the Czechoslovak universities and the representatives of the scientific and cultural life of our country, firmly convinced that work for peace and the fight to preserve it is one of the most basic duties of every true scientific and cultural worker who is conscious of his responsibility, express our deep indignation at the attack of American imperialism against Korea. This attack flagrantly violates the inalienable right of the Korean nation to self-determination and thus the principles of the Atlantic Charter.

It is a part of the policy of occupying and subjecting other nations of Asia and Europe, the countries of which are being changed into a springboard of the American armies in preparation for a new world war. This cynical violation of the principles and spirit of the Charter of the United Nations is hypocritically masked in the name of the United Nations Organisation, which is thus—under the pressure of dollar imperialism—estranged from its peace mission and turned into an aggressive bloc by its nonacceptance of the largest nation of the world—People's Democratic China—and by its provocative boycott of all the constructive proposals of the greatest peace power, USSR, and the countries of the people's democracies.

Therefore, together with all our people, who daily express their will for peace by their constructive work, and together with all the true friends of peace all over the world, we decisively condemn this criminal attack against the Korean nation and against world peace. We condemn the barbaric destruction of Korean towns and their flourishing cultural centres. We condemn most strongly the criminal intention to use the atomic bomb in Korea, which has been repudiated and condemned by world public opinion. We protest against the abuse of the United Nations Organisation and against its degradation, against the exclusion from its organs and its work of those very powers and countries that are the most reliable fighters for world peace. We demand the immediate cessation of the American intervention in Korea. We support (without reservation) the opinion of Generalissimo Stalin, expressed in his correspondence with Pandit Nehru, that the peaceful termination of the war in Korea and the solution of the Korean question are possible only through cooperation with People's Democratic China and with the participation of the representatives of the Korean nation. We stand with all our sympathy on the side of the Korean nation and its people's government, which by its policy has proved and is proving that it is the real and only representative of its nation, and which has given special care to the development of science and cultural life in its country.

We appeal to the scientific and cultural workers of all

countries to rise up with us in the defence of the independence of the Korean nation and in the defence of peace, which is gravely threatened by this American aggression. Only through the energetic and united action of all honest people—and among them in the first place belong all people of science and culture—is it possible to stop this criminal intervention, to restore to the United Nations Organisation its peace mission, and to safeguard world peace and the cooperation of nations.

DONE *at Prague, this twenty-fifth day of July, one thousand nine hundred and fifty.*

(Signed, with seals)

JAN MUKAROVSKY
Rector, Charles University
DR. LADISLAV STOLL
Rector, Vysoke Skoly Politickych a Hospodarskych ved
P. SMETANA[1]
Rector, Academy of Applied Arts

DR. STARY
Rector, Czech Technical University
DR. H. U. BROUSIL[1]
Rector, Academie Musickych Umeni
K. GRONOVI (?)[1]
Rector, Academy of Fine Arts

[1] The signatures are hard to read.

It would be interesting to learn the extent to which this document has been circulated among American scientific institutions and universities. It is clearly part of the same campaign to strengthen this particular Big Lie by putting behind it all the prestige of institutions of learning that have had fine reputations for many years. It is noteworthy that, in the 1947 edition of the *World of Learning*, the rectors of these institutions were all different from those who now head them. Presumably they have been replaced by men who are willing to put their names to manifestoes that the wisdom of the Politburo considers expedient.

Among the signers of the document quoted by Dr. Kleitman are such people as Oparin and Lysenko, who have, through bigotry or cynicism, adopted a point of view wholly at variance with Western objective science. It also bears the names of Varga and Orbelli. Here are two men who have attempted, at considerable personal risk, to combat the extreme position of the "Marxist scientists," whose doctrine of arriving at scientific hypotheses by political dicta is notorious. One would hazard a guess that such signatures are inspired by nothing more profound than the well-known instinct of self-preservation. Under the circumstances it is well not to be too critical of those who probably can see little hope that martyrdom would advance by one iota the pursuit of truth beyond the Iron Curtain.

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THE recent outburst of several Soviet scientists (*Science*, **112**, 475 [1950]) is another illustration of the complete subjugation of free speech in the USSR. It is easy to be misled into thinking that these men sincerely believe in what they are forced to say. Anyone who has lived even a short time in a totalitarian state, however, will have more insight and will not blame the scientists who signed the letter. Recently I witnessed a jingoistic discourtesy staged by the Russians at an international scientific gathering. Later one of them said to me privately, ". . . but if we don't do something like that, we shall have to answer for our 'political inactivity.'" During the last war, even the famous Max Planck was unable to communicate to the outside world that his supposed support of the Nazi official philosophy was a complete misrepresentation.

Let us have more charity toward people behind bars with pistols pressed to their backs.

FORMER RUSSIAN SCIENTIST
(*Name withheld by request*)

NATHANIEL KLEITMAN in his letter "The Big Lie" (*Science*, **112**, 475 [1950]) thinks that the "protest" of prominent Soviet scientists against American "intervention" in Korea is made because of "anticipated hysteria that seems to have gripped all classes of people behind the totalitarian curtain."

I only recently ran away from the Soviet Ukraine, where I lived the whole of my life, and where I was professor in one of the medical institutes. I would like to inform Mr. Kleitman and all other scientists about the "technique" of writing of such "protests."

The text of the "protest" is composed in the headquarters of the Communist Party without any participation of scientists. The latter are asked to sign the prepared "protest," being summoned to headquarters or being visited by some responsible Communist. One must have immense courage and audacity to refuse to sign, because every scientist knows very well that after refusing he risks being included in the category of American sympathizers or even in the category of "people's enemies," with all possible consequences for himself and members of his family. Therefore every scientist requested to sign would not hesitate one minute.

I think he is not afraid of misleading public opinion abroad with his signature, because he has a very high opinion of the mentality of foreign scientists, and he has no doubt that the truth will not be hidden from them.

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NATHANIEL KLEITMAN'S communication (*Science*, **112**, 475 [1950]) about the statement of the Russian scientists on the Korean war seems to demonstrate a phenomenon that is not limited to the Soviet Union but is found in any modern society.

My own unscientific sampling has convinced me that higher education—particularly technical education—and professional, economic, or business status are no

guarantee of immunity to the prevailing myths that govern a society. Indeed, it appears to me that such people are even more susceptible than those of lower economic, educational, or social status. It would be a valuable, if exceedingly difficult, task for a good sociologist to study the correlation, if any, between status and the ability to view one's culture with detachment.

Some evidence is already available. The Lynds, in their study of Middletown, listed a great many myths (which had little relation to objectively observed facts) that were held by the business class as tenets of faith even more important to their lives than the professed doctrines of their churches. Gunnar Myrdal showed how the myths of race varied with classes in the South, but the myths of the upper classes seemed no closer to reality as Myrdal saw it than those of the lower classes. The recent election, fought from both sides in large measure on substantially false issues, might be adduced as supporting data.

Thurman Arnold, no trained sociologist but an astute observer, pointed out in *The Folklore of Capitalism* how, without any thought of compulsion or expediency, the sound, well-thought-of, respected people in any community are particularly enmeshed in the current mythology and the institutional *status quo*, and are unable, even when the need is obvious, to take part in changing it.

The statement of the Soviet Academy would be ludicrous were not the subject so serious. But is it not an acute case of a disease that afflicts us all?

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Separation of Organic and Inorganic Compounds

THE paper of McDonald, Urbin, and Williamson (*Science*, 112, 227 [1950]) is so very interesting that it will undoubtedly attract considerable attention. It is therefore worth while to comment critically upon their final paragraph, in which they contemplate experiments on the movement of ions on a filter paper under the influence of both an electric and a magnetic field. "In effect, this system would be equivalent to a mass spectrograph applicable to charged particles in solution." The implication appears to be that the masses of charged particles in solution could be measured by this method.

In the mass spectrograph, the ions are moving freely in a vacuum, and any force exerted upon them, electrical or magnetic, will result in an acceleration, depending upon the ionic properties of charge and mass. The mass spectrograph is merely a mechanism for converting the variable response of the particles to the forces from a linear effect, which would be very difficult to observe, to a transverse effect easily recorded on a photographic surface.

In the case of ions in solution there are two essential differences. In the first place, the ions are not moving freely, they do not accelerate continuously but reach a constant velocity in an extremely short time, and this velocity, which is measurable, is dependent upon the ionic properties of charge and size, not mass. Second, with ions in solution it has been possible to devise methods of investigating the "linear" effect—that is, the varying movements of ions traveling along a straight line—so that there is no real need to convert to the transverse effect in order to observe them. The introduction of the magnetic field would give no more information on the mass or size of the ion than do present electrical methods.

I hope that this comment will do more to draw attention to this interesting paper pioneering this new research method than to detract in any way by criticism.

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Indonesian Place Names

SOME biologists who, like myself, have only occasional contact with workers in the East Indies may not fully realize the nature of recent changes in place names. I am indebted to D. A. Hooijer, a vertebrate zoologist of the Leiden Museum, who is temporarily in the United States, and who has spent much of his life in the Dutch East Indies, for clarifying this subject. With the change from Dutch administration to native control there has been a substitution of native Indonesian names for names of Dutch sponsorship, which in most cases are those we have been accustomed to see and use. Thus, the Zoölogisch Museum, where such well-known entomologists as M. A. Lieftinck (Odonata) and A. Diakonoff (Micro-lepidoptera) have been working, has not moved, but the original Indonesian name Bogor has replaced Buitenzorg. In the same way Batavia has been replaced by Djakarta (sometimes appearing in newspapers in the U. S. as Jakarta). Dr. Hooijer tells me that the use of the Indonesian names is highly important in addressing mail, as that bearing Dutch place names is likely not to be delivered, because of the present attitude of postal authorities in the Republik Indonesia Serikat (R.I.S.) ("United Indonesian Republic").

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Erratum

In reference to paper by Bacchus and Toompas, "The Influence of Ascorbic Acid on the Leukocyte Response of Rats Submitted to Stress" (*Science*, 113, 269 [1951]), in order to bring the numbering of groups on page 269 in accord with that on page 270, Group I (one) should be regarded as *saline pretreated*, and Group II (two) as *ascorbic acid pretreated*.

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Book Reviews

Wave Theory of Aberrations. H. H. Hopkins. New York: Oxford Univ. Press, 1950. 169 pp. $3.00.

Book titles can be misleading, for actually less than half of the present book deals with the wave theory of lens aberrations. The derivation of the properties of aberrations from the shape of the image-forming wave front is an old science, and the transfer from wave-front to ray aberrations is a straightforward matter, since rays are merely the normals to the wave front. In this little book, Dr. Hopkins has made a useful collection of these derivations, based largely on Conrady's papers of 1905 and 1918–20, with some additional proofs and formulae of his own. A large part of the book is, however, devoted to ray-tracing methods and computing procedures, which are quite conventional and have little relation to the title. Indeed, many of the author's statements will be found intact in Conrady's *Applied Optics and Optical Design.*

One would have expected to find that a book on the wave theory of aberrations would also include the effects of diffraction in the elementary image. A consideration of the mutual interference of Huygenian wavelets, originating at every point on the wave front as it emerges from the lens, enables us to compute the detailed light distribution or fine structure of the elementary image associated with each aberration. Unfortunately this approach to the subject has been entirely omitted in the present book.

The mathematics involved is simple, but the inclusion of a few numerical examples would greatly help the reader to understand the formulae. The book should be useful to anyone engaged in lens computation or design.

R. Kingslake

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Dementia Praecox or the Group of Schizophrenias. Eugen Bleuler; translated by Joseph Zinkin. New York: International Universities Press, 1950. 548 pp. $7.50.

Bleuler's monumental work on schizophrenia is probably the most important book ever written in psychiatry, dealing as it does with this most common and protean of diseases of the mind. What makes the book so important is not that schizophrenia is so common but that it is so frequently not recognized. In this book Bleuler delineates with great clinical acumen, and describes in clear language, the disease he named schizophrenia and removes it from that artificial and rigid classificatory system of a multiplicity of mental diseases that Kraepelin gave psychiatry at the beginning of the century. Kraepelin masterfully described and classified the *symptoms* of the two psychoses dementia praecox and manic-depressive states; Bleuler had the sagacity to recognize the *nature* of the disease, and had the courage to say that in medicine one cannot base diagnosis upon either the prognosis or upon the course of the disease, but only upon knowledge and recognition of the disease.

The fundamental manifestations of schizophrenia are seen in a specific loosening of associations, in disturbances of affect, and in autistic thinking. These may result in ambivalence, blocking, and autism. Such gross manifestations as delusions and hallucinatiens (psychosis) are, according to Bleuler, only accessory symptoms, and for the diagnosis relatively unimportant.

Since the majority of schizophrenics are not psychotic, but since the majority of these nonpsychotic schizophrenics do also demonstrate neurotic symptoms, it becomes exceedingly important to differentiate diagnostically between schizophrenia and the neuroses, as the latter are not diseases of the ego. The symptomatological differentiation between neuroses and psychoses still in use today is a Kraepelinian heritage which should give way to the understanding of the disease schizophrenia, which frequently straddles both. Bleuler's contribution to psychiatry is as significant as is the ability to diagnose liver disease before jaundice is visible, in internal medicine, or nephritis before signs of edema occur, or coronary disease before coronary accidents take place.

The book was published in German in 1911, during a period of great diagnostic activity but also of therapeutic nihilism (aside from Freud and his then small circle of students). Now, 40 years later, the pendulum has swung, and we appear to be in a period of diagnostic nihilism and therapeutic anarchy. It is most timely, then, that this great book—which should be on every medical student's desk and on every physician's reading shelf—has finally been translated into English. Joseph Zinkin deserves high praise for his lucid translation, as does Gregory Zilboorg for his long advocacy of the belated undertaking.

Carl Tillman

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Cell and Psyche: The Biology of Purpose. Edmund W. Sinnott. Chapel Hill, N. C.: Univ. North Carolina Press, 1950. 121 pp. $2.00.

In his John Calvin McNair Lectures, the distinguished author gives a popular presentation of his biological world view. The distinctive character of life is organization. This central problem presents itself in the orderly distribution and cooperation of enzymes and other biocatalyzers, as well as in the control of morphogenesis shown, for example, in the formation of sporangia of slime molds from a mass of ameboid cells, in the regulation of innumerable chemical re-

actions for maintaining the steady state of the open system "organism," in development where the organizer is but a stimulus, the problem of organization resting in the responding system, in gene action where thousands of genes cooperate and numerous chemical reactions, accurately timed and located, are involved to produce a complex individual.

Despite all the advances in physical chemistry of cells, physiology, etc., we have no adequate explanation of biological organization. The hypothesis proposed by the author is that the close resemblance between regulatory or "goal-directed" processes of development and physiological activity on the one hand, and the purposiveness of mental or psychological activities on the other, indicates that both are fundamentally the same thing. Growth, physiological reactions, and true behavior form an ascending series the steps of which grade into each other imperceptibly. Unconscious purpose at the beginning has finally evolved into consciousness. Thus, body and mind, including the highest manifestations of spiritual activity, are two aspects of the same biological phenomenon. From this standpoint, purpose appears to be essentially similar to the tendency toward developmental and physiological equilibria; freedom is rooted in the emergent and creative character of life and mind; individuality is found as well in the biological perseverance of organization in continuous change of the components as in the ego; and man finds his place in the universe as the most subtle expression of protoplasmic activity.

Much could be said about the author's position both from the viewpoint of science, where it seems doubtful in what way physio-psychological monism is helpful in the interpretation of phenomena, and from the philosophical standpoint, where the problems of human mind are hardly touched by the simple statement of evolution. But the book makes excellent reading, and its value is in emphasizing two fundamentals often overlooked: first, the central problem of organization which is not solved by accumulating an ever-increasing number of data on biochemical reactions, enzymes, hormones, and the like; second, that it is, in the last resort, not material things, economic and social factors, but great ideas that are decisive for human destiny.

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Scientific Book Register

Geography of Russia. N. T. Mirov. New York: Wiley; London: Chapman & Hall, 1951. 362 pp. $6.50.

Geography of the USSR: A Regional Survey. Theodore Shabad. New York: Columbia Univ. Press, 1951. 584 pp. $8.50.

Propagation of Short Radio Waves. M.I.T. Radiation Laboratory Series, Vol. 13. Donald E. Kerr, Ed. New York-London: McGraw-Hill, 1951. 728 pp. $10.00.

Plant Growth Substances. Folke Skoog, Ed. Madison, Wis.: Univ. Wisconsin Press, 1951. 476 pp. $6.00.

The Affairs of a Tribe: A Study in Tribal Dynamics. Dhirendra Nath Majumdar. Lucknow, India: Universal Publishers, 1950. Published for the Ethnographic and Folk Culture Society, U. P. 367 pp. Rs. 23/8.

Stratigraphy and Sedimentation. W. C. Krumbein and L. L. Sloss. San Francisco, Calif.: Freeman, 1951. 497 pp. $5.00.

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News and Notes

The Faraday Society Discussion

Barry Commoner

The Henry Shaw School of Botany, Washington University, St. Louis, Missouri

A FARADAY SOCIETY DISCUSSION was held at Cambridge, England, September 25–28, 1950, on two related topics: "Spectroscopy and Molecular Structure" and "Optical Methods of Investigating Cell Structures." The meeting was attended by several hundred persons, nearly one third coming from countries other than England. The papers presented during the first part of the discussion traversed the spectrum from the vacuum ultraviolet through microwaves, dealing with electronic, vibrational, and rotational spectra of relatively simple molecules, and with vibrational spectra of substances as complex as rubber, cellulose, nylon, and plastics.

The discussion of electronic spectra centered around the efforts of Kasha, Sponer, and others to provide quantum-mechanical interpretations of electronic transitions occurring in molecules such as substituted benzenes and naphthalenes. Evidence of their success could be seen, for example, in Kasha's demonstration that the intensification of spin-orbital coupling by substitution of heavy atoms in organic molecules predicted by quantum-mechanical theory does indeed occur. A good deal of the information presented during these discussions was based on recent studies of the fluorescence of crystals and rigid glass solutions of organic molecules.

The papers dealing with rotational and vibrational spectra of relatively simple molecules were chiefly concerned with determination of the force constants of bonds occurring in organic compounds. Considerable attention was given to the properties of the hydrogen bond, especially in solids. Two discussants (Pestemer and Romand) reported independent observations that the presence of hydrogen-bonding may, in certain instances, be demonstrated by ultraviolet absorption.

A paper by E. B. Wilson described the potential applications of microwave spectroscopy to structural analysis. The new method permits the determination of rotational constants (of unsymmetrical molecules) with a precision about one hundred times greater than that afforded by infrared measurements. It was later pointed out by Herzberg that thus far the two methods give remarkably good agreement when applied to the same molecule.

The contributions on the infrared spectra of polymeric substances were necessarily empirical, dealing in the main with the problem of assigning absorption bands to appropriate intramolecular motions. It was noteworthy that investigators in this field showed an increasing interest in macromolecular substances of biological importance, including proteins, cellulose, chitin, and rubber. Several papers dealt with the use of polarized infrared radiation as a means of determining the spatial orientation of bonds responsible for absorption in the infrared.

The second part of the discussion brought together a number of investigators who have attempted to apply spectroscopic methods to analysis of the composition of single cells and cell structures. These techniques, originally developed by Vlès and Gex in France and later refined by Caspersson's extensive work at Stockholm, have spread rapidly in the past five years to a number of laboratories in England, the United States, and the USSR. A number of these groups were represented at the Faraday Society meeting, and as a result the discussion was marked by a diversity of viewpoints. General summaries of the present state of microspectrophotometry were presented by Randall and Barer. The latter considered the difficulties involved in applying infrared spectrometry to cytological objects.

Developments in instrumentation were discussed by Wilkins (spherical reflecting objectives for UV), Barer (the Burch aspherical reflecting objective), Walker and Davies (ultraviolet microcinematography), and Thorell (recording microspectrophotometer). Engstrom described results obtained with newly developed x-ray absorption techniques. During this part of the discussion considerable disagreement was expressed concerning the relative merits of aspherical and spherical reflecting objectives. The former are expensive and difficult to produce; the latter seem to have a rather small coma-free field, according to the views of Barer, Taylor, and Kehoe.

Subsequent papers discussed results obtained from microspectrophotometric investigations of various biological objects. It is noteworthy that these reports were largely concerned with measurements of living cells rather than with fixed tissues. Investigations by Bradfield showed that the ultraviolet absorption of initially living cells is rapidly altered during irradiation. This provides quantitative confirmation of the observations first noted by Vlès and Gex in 1928 and also reported by Larianov and Brumberg in 1946. It raises a number of serious issues concerning the meaning of data obtained from fixed cells, which need to be resolved before sound conclusions may be drawn from intracellular UV absorptions. Ultraviolet absorption spectra of structures in living cells were reported by Walker and Davies and by Commoner. The former reported the UV absorption spectra of the nucleus and nucleolus of living fibroblasts. These were based on measure-

ments through single points in the cell, and on the assumption that underlying and overlying material made a negligible contribution to the absorption. The latter showed that in certain living plant cells the actual UV absorption spectra of the nucleus itself could be determined by measuring a minimum of three absorption spectra through appropriate regions of the cell. Similar procedures yielded the separate spectra of the vacuole contents and the protoplast layer. In the discussion which followed these papers it was pointed out that the heterogeneity of optical sections through living cells made it difficult to interpret the meaning of absorption maxima from single points in the cell. These and other considerations led some discussants to suggest that in many instances intracellular absorption measurements may provide only qualitative information concerning cell composition, and that quantitative interpretations must be viewed with considerable caution.

These problems appear to reflect the present transitional state of microspectrophotometry. Investigators participating in the Faraday Society Discussion were seriously concerned with the development of means for critical evaluation of absorption measurements of cytological objects. That such criteria are yet to be fully expounded was apparent from the reluctance of most investigators to draw more than tentative conclusions from the data obtained.

The hospitality extended to the participants by the Colleges of Cambridge University did much to make the meeting a successful one; the dinner in the great hall at Trinity College was a highlight. In arranging this timely meeting the Faraday Society has made a significant contribution to the development of spectrometry. That the meeting was lively, critical, and squarely directed toward important issues reflects the society's traditional interest in those vital areas of research that represent the interpenetration of physics, chemistry, and biology.

Scientists in the News

George E. Byers has become assistant production director of Henry K. Wampole & Company, Philadelphia. He was formerly director of pharmaceutical production, Carroll Dunham Smith Pharmacal Company, New Brunswick, N. J.

The South Pacific Commission has engaged **L. R. Catala** to carry out its project for improvement of resources on coral atolls. Dr. Catala has been released for 6 months by the Institut Français d'Oceanie (Noumea) for this work, and will be assisted by **Mrs. Catala.** Their investigations will include a survey of the physical environment in the islands, with a view to discovering ways of increasing the quantity and variety of subsistence and commercial crops, improving domestic animals, and exploiting fisheries and native handicrafts.

Ivor Cornman, assistant research professor of anatomy at the George Washington University, has received a grant from the American Cancer Society of $4,294 to aid in the search for antibiotic drugs that will destroy cancer cells without harming normal tissue. Dr. Cornman will make tests with antibiotic drugs being developed at George Washington's Department of Medicine by **Monroe J. Romansky,** associate professor of medicine.

Olive W. Dennis has retired as research engineer for the Baltimore & Ohio Railroad. Miss Dennis began railroading in 1920, when she went to work as a draftsman in the bridge engineering department of the B & O. Within a year, she was appointed to the position of engineer of service and in 1946 she became research engineer. Miss Dennis has a degree in civil engineering from Cornell University. She was the first woman member of the American Railway Engineering Association and has been for many years a member of its Committee on the Economics of Railway Location and Operation. As research engineer, Miss Dennis' job has been to study and recommend improvements in passenger service and equipment and to make studies concerning efficiency and economy in railway operations.

Joseph C. Elgin has been appointed associate dean of the school of engineering at Princeton University. Dr. Elgin, who is chairman of the university's department of chemical engineering, is now on sabbatical leave but will resume his duties as chairman and as associate dean next fall. He is also consultant for the Atomic Energy Commission and a trustee of Associated Universities, Inc., which operates Brookhaven National Laboratory.

The Willard Gibbs Medal for 1951 has been awarded to **William Francis Giauque,** of the University of California. The award, conferred annually by the Chicago Section of the American Chemical Society, will be presented to Dr. Giauque at a dinner on May 18. The 1951 medalist is internationally known for his research at low temperatures, for which he won the 1949 Nobel prize in chemistry. He was the first to demonstrate, in 1933, the magnetic method for approaching absolute zero.

Peter V. Karpovich, professor of physiology, Springfield College, Springfield, Mass., has been appointed consultant to the Army Surgeon General. Dr. Karpovich is conducting a study supported by a grant given by the joint armed forces regarding the comparative merits of various methods of artificial respiration.

Recent visitors at the National Bureau of Standards were **R. Kikuchi,** Department of Physics, University of Tokyo; **C. Sanders,** of the National Research Council of Canada, photometry section; and **Y. Tamura,** of the Osaka Industrial Research Institute, Japan. Fourteen members of the Secondary Non-Ferrous Metals Smelters and Refiners Productivity Team from France, in the U. S. under the auspices

of ECA, toured the metallurgy and chemistry laboratories.

John Gamble Kirkwood, professor of chemistry at Caltech, has been named Sterling professor of chemistry and chairman of the Department of Chemistry at Yale. He will assume the professorship on July 1 as part of a Yale program to strengthen her science faculties. He has been Arthur A. Noyes professor at Caltech since 1947.

The American Water Works Association has awarded its John M. Goodell Prize for 1950 to **Malcolm S. McIlroy,** professor of electrical engineering at Cornell University. The certificate and a cash award are given to the member who has made the most notable contribution to the science of water works development during the year. Formal presentation will be made at the association's annual conference in Miami in May. Professor McIlroy was cited for the development of an electrical apparatus to study pressure flows in pipeline networks.

Albert M. Mattocks has been appointed manager of the Pharmaceutical Development Department of McNeil Laboratories. Dr. Mattocks was formerly director of the laboratory of the American Pharmaceutical Association, with headquarters in Washington, D. C.

The influence of science and technology on civilization will be discussed in the 1951 Haynes Foundation Lecture series at the California Institute of Technology in April. **C. E. Kenneth Mees,** of Rochester, N. Y., will speak April 2, 4, and 6 on "Technology and Civilization," "Science and Technology," and "The Effect of Technology on the Organization of Society." Dr. Mees, a native of England, received his D.Sc. degree from the University of London. He came to this country in 1912 as research director for Eastman Kodak and since 1934 has been its vice president in charge of research.

Hans Popper, associate professor of pathology in Northwestern University's Medical School, has been appointed to the editorial board of *Gastroenterology.* Dr. Popper also is director of the pathological laboratories at Cook County Hospital, Chicago.

Robert H. Seashore, chairman of the Department of Psychology at Northwestern, is now at the School of Aviation Medicine, Randolph AFB, working on a research project for the USAF. Dr. Seashore, whose special field is analysis of human abilities in relation to difficult performances and the operation of complex machines, will try to sift from the literature the most important psychological tests and methods that may be useful to the Air Force in selecting and training personnel.

H. T. Shortt and **P. C. C. Garnham** were awarded the Darling Foundation Prize for their joint work on the life cycle of the malaria parasite in man and monkey, and **Rene Sand,** of Belgium, was nominated for the Leon Bernard Foundation Prize for achievements in social medicine. The Darling Foundation Prize consists of a bronze medal and 1,000 Swiss francs. Set up by the League of Nations to honor the famous malariologist, S. T. Darling, it was last awarded in 1938. The present recipients were selected by WHO and the Darling Foundation committee. Professor Shortt occupies the chair of medical protozoology at London University and is president of the Royal Society of Tropical Medicine and Hygiene. Dr. Garnham, a reader in medical parasitology at London University, spent many years in Africa, where he became widely known for his studies in tropical medicine, epidemiology, and malaria. Rene Sand holds the chair of social medicine at Brussels University. The Leon Bernard Foundation Prize was established by international subscription in perpetuation of the memory of Leon Bernard, of France, a member of the League of Nations Health Committee. The prize, which consists of a medal and 1,000 Swiss francs, was last awarded in 1939.

K. S. Spiegler, on leave of absence from the Weizmann Institute of Science in Rehovoth, Israel, has been appointed Weizmann Institute Postdoctoral Fellow at MIT for the current academic year, to work on electrochemical properties of ion-exchange resins.

For outstanding achievement in the chemical study of food allergy and immunology, three USDA chemists have won the 1950 Hillebrand Prize of the American Chemical Society's Washington Section. The winners are **Henry Stevens,** head of the Allergen Research Division of the Bureau of Agricultural and Industrial Chemistry, and two associates, **E. Jack Coulson** and **Joseph R. Spies.** A major accomplishment of the group has been the demonstration that cottonseed oil in food products does not cause allergies, as had heretofore been widely suspected. The prize, a cash award, was established in 1925 in honor of William Francis Hillebrand, chief chemist of the National Bureau of Standards from 1908 to 1925. It is conferred annually upon a member (or members) of the Washington Section in recognition of a notable contribution to chemistry during the 3 preceding years.

Percy Tham, head of the Photogrammetry Office, Department of the Royal Geographic Survey, University of Stockholm, is a current visitor in the U. S. Among his projects is the discussion of photogrammetric problems with members of the Topography Division, U. S. Geological Survey.

M. Tigerschiold, director of research, Jernkontorek, Sweden, has been awarded the Carl Lueg Medal of the Verein deutscher Eisenhuttenleute.

The Section of Science of the Royal Netherlands Academy of Sciences and Literature has awarded the Leeuwenhoek Medal to **S. A. Waksman,** of Rutgers University. The medal is given every 10 years to the scientist who in the past decade has made the most remarkable observations on microscopical organisms, first discovered by Leeuwenhoek in 1675.

Colleges and Universities

A course on "Techniques and Applications of the Electron Microscope" will be given again this summer in the **College of Engineering Physics at Cornell** from July 9 to 11. The course is designed for institutional and industrial research workers who have recently entered the field or who are planning research involving the use of the electron microscope. For further information, write to Benjamin M. Siegel, Rockefeller Hall, Cornell.

The **University of Havana** summer school session for foreigners, especially North American teachers and students, will extend from July 20 to August 11. Spanish at all levels will of course be offered, and some courses in general fields, a few of which will be in English, but the majority in Spanish. There will be a seminar on Inter-American Relations, July 23–August 4, extracurricular lectures by Cuban and Latin-American scholars, and visits to places of historic interest, sugar mills, and tobacco plantations. For additional information, address the Secretary of the Summer School.

McGill University Geography Summer School will be held July 2–August 11 at Stanstead College, P. Q. Special courses will be given on arctic geography by Patrick D. Baird, Montreal director of the Arctic Institute of North America, which endorses the program; also courses on the geography of Canada, Europe, the Soviet Union, and South Asia. The teachers' program will be directed by Neville Scarfe, the graduate and undergraduate program by Bogdan Zaborski. Other members of the staff will be William F. Christians, Brian Bird, Sir Hubert Wilkins, and Kenneth Hare, Director, to whom inquiries should be addressed at McGill University, Montreal.

Michigan State's Departments of Bacteriology, Biological Science, Botany, Physiology, and Zoology are sponsoring a "Symposium on Phosphorus Metabolism," April 25–27. Speakers will be G. Evelyn Hutchinson, Yale; Henry A. Lardy, University of Wisconsin; Jacob Sacks, Brookhaven National Laboratory; Harry G. Albaum, Brooklyn College; and Harold C. Hodge, University of Rochester. Ralph W. Lewis, Department of Biological Science, will supply additional information.

Advanced courses in mathematics will be given this summer at Boston University (May 28–July 7); Catholic University (July 2–August 11); Cornell (July 2–August 11); Duke (June 12–July 21); Northwestern; Ohio State (June 19–August 31); Iowa State (June 12–August 8); Syracuse; Buffalo (July 2–August 11); California—Los Angeles (June 18–August 11); Chicago (June 26–September 1); Colorado (June 18–July 20); Detroit (June 25–August 3); Kansas (June 7–August 4); Kentucky (June 18–August 11); Maryland (June 23–August 3); Michigan (June 25–August 17); Minnesota (June 18–July 28); Nebraska (June 5–July 27); North Carolina (June 11–July 19); Oklahoma (June 8–August 3); Southern California (June 25–August 4); Wyoming (June 18–July 20); Virginia (June 25–August 18); Wisconsin (June 25–August 17); and West Virginia (June 6–July 17).

The **University of Tennessee** has awarded its first Ph.D. in chemical engineering to Franklin S. Chance, Jr., who is now associated with Chas. Pfizer & Co. Tennessee is offering specialization in metallurgy, microbiology, nuclear technology, and chemical engineering. In special cases, the department uses some of the laboratory facilities of the Oak Ridge Institute of Nuclear Studies and divisions of the Oak Ridge National Laboratory. Fellowships in amounts ranging from $1,400 to $2,100 are available to graduate students.

Grants

New awards bring to a total of 371 the number of unclassified research projects supported by the **Atomic Energy Commission.** New contracts in biology and medicine went to Washington State (C. O. Stanberry); Yale (John H. Heller); Cincinnati (Robert A. Kehoe); Michigan State (H. B. Tukey); Virginia (A. Chanutin); Tulane (W. S. Wilde); Louisiana State (John F. Christman); North Carolina (Maurice Whittinghill); and Washington University (Wendell G. Scott, Michel Ter-Pogossian). New contracts in physics were awarded to Rensselaer Polytechnic (D. C. Moore and G. N. Glasoe); in metallurgy to Armour Research Foundation (Max Hensen); and in chemistry to Oklahoma A & M (T. E. Moore).

Nine new special control grants have been awarded by the **USPHS** for the study of cancer to: University of Southern California School of Medicine (John W. Mehl and Hugh A. Edmondson; Edward G. Jones and Ian Macdonald); University of Maryland Medical School (Russell S. Fisher); Washington University (Evarts A. Graham); University of Pennsylvania (George C. Lewis); Nix Tumor Clinic, San Antonio (Dudley Jackson); University of Texas, Medical Branch (M. Mason Guest); University of Texas, M. D. Anderson Hospital for Cancer Research (William O. Russell); and University of Utah (John Z. Bowers).

The **Samuel Rubin Chair in Anthropology** at Brandeis University (Waltham, Mass.) has been established by Samuel Rubin, New York perfume manufacturer who was one of the founders of the New York University–Bellevue Medical Center. The establishment of this chair will enable the two-year-old institution to start a program of research to determine the impact of cultural factors on social organization in the U. S.

The **Swedish Humanistic Fund** has distributed 103 grants totaling $80,000 for research that will include investigations concerning population movements on the island of Gotland in ancient times. The **Swedish Natural Science Research Council** has made grants amounting to $125,800, of which part will go toward

preparing for publication the extensive findings of the Swedish *Albatross* Oceanographic Expedition; H. Kullenberg, of Gothenburg, a member of the expedition, was given 10,000 kr. toward perfecting his vacuum plummet for taking sediment cores from the ocean floor. Other funds were allocated to a zoological expedition to East Africa and to glaciological, botanical, and physiological research.

Miscellaneous

With the cooperation of the insecticide industry, the **American Association of Economic Entomologists** Section on Insecticides has undertaken the sponsorship of insecticide reference standards. These are intended chiefly for bioassays of insecticides, but they are also suitable for use as standards for chemical assays. The following AAEE Reference Standards will be available on April 1: DDT, technical grade; methoxychlor, technical grade; lindane; toxaphene; tetraethyl pyrophosphate, 40%; parathion, technical grade; and chlordane, technical grade. Order must be accompanied by remittance of $1.00 per standard, and all shipments will be made by collect express. Send orders to Wisconsin Alumni Research Foundation, Insecticide Testing Laboratory, Madison 1.

The **National Research Council's Committee on Geophysics Advisory to the Office of Naval Research** will meet May 3 to consider projects in geophysical research. Those who wish support for basic research in this field should submit five copies of their proposal and a letter of endorsement signed by the president or authorized financial officer of their institution to the Office of Naval Research, Department of the Navy, Washington 25, D. C. Investigators forwarding their proposals by way of ONR area branch offices are urged to send an advance copy to the Geophysics Branch of ONR in Washington. Guides for the preparation of research proposals are available from ONR. To be considered at the meeting, proposals should be received in Washington not later than *April 16*. It is the policy of the committee to recommend only projects submitted in the name(s) of the principal investigator(s), who are expected to participate actively in the research.

A new quarterly, ***Documenta Neerlandica et Indonesica de Morbis Tropicis,*** is being published (in English) in the Netherlands. There will be approximately 100 pages per issue, with articles on original research in tropical diseases. N. H. Swellengrebel is chairman of the editorial board, and the subscription price is $4.50.

An appeal has been issued by the **Royal Society** of Great Britain for subscriptions to a memorial fund to establish scholarships in honor of Lord Rutherford, nuclear physics pioneer. The money will be used to set up Rutherford Scholarships tenable for three years, to be awarded to postgraduate students within the British Commonwealth, and a Rutherford Memorial lecture to be delivered in New Zealand—Rutherford's birthplace—and elsewhere in the Commonwealth. Publication of Rutherford's papers and correspondence is also planned.

Beginning with Volume XXXI, Number 1, March 1951, the title of *Archives of Biochemistry* (Academic Press) was changed to ***Archives of Biochemistry and Biophysics.*** In addition to established biochemical topics, the editors wish to consider manuscripts in the fields of virus research, radiation effects on living matter, macromolecular biology and chemistry, the application of radioactive indicators, and physics of biological systems. E. Newton Harvey, E. C. Pollard, and R. W. G. Wyckoff have been added to the Editorial Board.

Bulletin No. 121, ***Sanitary Milk and Ice Cream Legislation in the United States,*** is now available without charge from the Publications Office of NRC. The bulletin is a report on the first part of a study of milk regulations in relation to milk quality undertaken by the NRC Committee on Milk Production, Distribution, and Quality. The complete project includes two major phases: a compilation and analysis of state and municipal statutes and regulations on the production and handling of fluid milk products, and the effect of these laws on the quality of the milk, as measured by their administration and enforcement as well as by actual experimental procedures. The first part of the research has been completed and is reported on in the bulletin; the second study is now under way. The project is under the direction of A. C. Dahlberg, of Cornell University.

The **New York Botanical Garden–Kunhardt** expedition to the Guiana Highlands in Venezuela has collected nearly 1,500 South American plants, mainly members of the Compositae, Guttifereae, and Rapateacea, which will be added to the extensive collection in the Garden herbarium. Bassett Maguire has rejoined the expedition at San Guam and plans to collaborate with the British Guiana Forest Department in an expedition to the eastern end of the Pacaraima range. The Garden hopes later to explore the mountains on Africa's west coast with a view to discovering the relationship, if any, between the isolated flora of that region and that of Guiana. Information on the evolution of plants and the theory of continental drift is also expected to result from such exploration.

Refinery Supply Company, Tulsa, Okla., has become a wholly owned subsidiary of the Cenco Corporation. W. A. Schlueter will continue as president of Refinery Supply, in addition to serving as director and vice president of Central Scientific Company.

Reconstruction of **Dechema House** has progressed so far that Deutsche Gesellschaft fur chemisches Apparatewesen E V expected to be able to take up its work there on March 1. At that date also the branch office of the Technical Standardizing Committee for the Chemical Plant, and the branch office of the Technical Committee for the Standardization of Chemical Laboratory Apparatus, took up their activities in Dechema House.

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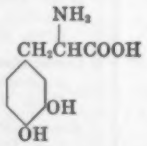

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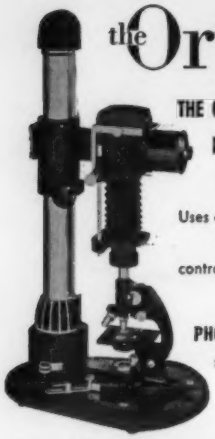

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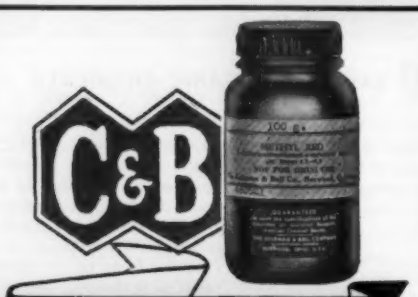

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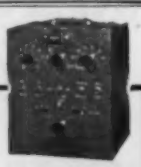

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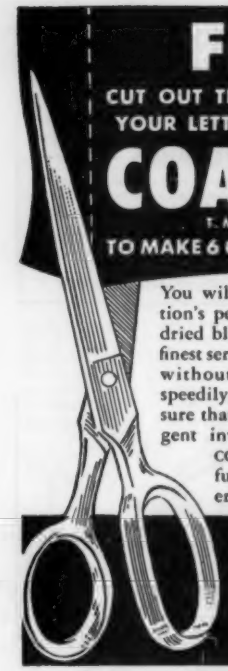

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Apr. 6–7. Texas Academy of Science (South Texas Regional). Corpus Christi.

Apr. 8–11. Electrochemical Society. Wardman Park Hotel, Washington, D. C.

Apr. 9–13. American College of Physicians (Annual). St. Louis.

Apr. 11–13. Faraday Society Symposium on Hydrocarbons. Oxford, Eng.

Apr. 11–13. American Surgical Association. Washington, D. C.

Apr. 13–14. Geological Society of America, Rocky Mountain Section. South Dakota School of Mines and Technology, Rapid City.

Apr. 16–18. American Society of Lubrication Engineers (Annual). Bellevue-Stratford Hotel, Philadelphia.

Apr. 16–18. Union Radio Scientifique Internationale. National Bureau of Standards, Washington, D. C.

Apr. 18–20. National Petroleum Association. Hotel Cleveland, Cleveland.

Apr. 19–21. American Philosophical Society (Annual). Philadelphia.

Apr. 20–21. British Association of Physical Medicine. London.

Apr. 20–21. College of American Pathologists (South Central Regional). The Shamrock, Houston, Tex.

Apr. 20–21. Symposium on Fundamental Cancer Research of the University of Texas M. D. Anderson Hospital for Cancer Research (Annual). The Shamrock, Houston, Tex.

Apr. 20–21. Nebraska Academy of Science. University of Nebraska, Lincoln.

Apr. 21–May 6. Liége International Fair for Mines, Metallurgy, and Mechanical and Electrical Engineering. Liége, Belgium.

Apr. 22–26. American Ceramic Society. Palmer House, Chicago.

April 22–27. Navy Industrial Health Conference. Chalfonte-Haddon Hall, Atlantic City.

Apr. 23–24. Industrial Accident Prevention Associations (Annual). Royal York Hotel, Toronto.

Apr. 23–25. National Academy of Sciences. Washington, D. C.

Apr. 24–25. American Venereal Disease Association and National Institutes of Health Symposium on Advances in Luetic Control. Federal Security Building, Washington, D. C.

Apr. 23–27. Health Congress. Southport, Eng.

Apr. 26–28. American Physical Society, Division of High Polymer Physics. Washington, D. C.

Apr. 27–28. Midwestern Psychological Association. The Drake, Chicago.

Apr. 27–28. Georgia Academy of Science, Earth Science Division. University of Georgia, Athens.

Apr. 27–28. West Virginia Academy of Science (Annual). Marshall College, Huntington.

Apr. 28. American Psychosomatic Society (Annual). Chalfonte-Haddon Hall, Atlantic City.

Apr. 27–28. Western Psychological Association. San Jose State College, San Jose, Cal.

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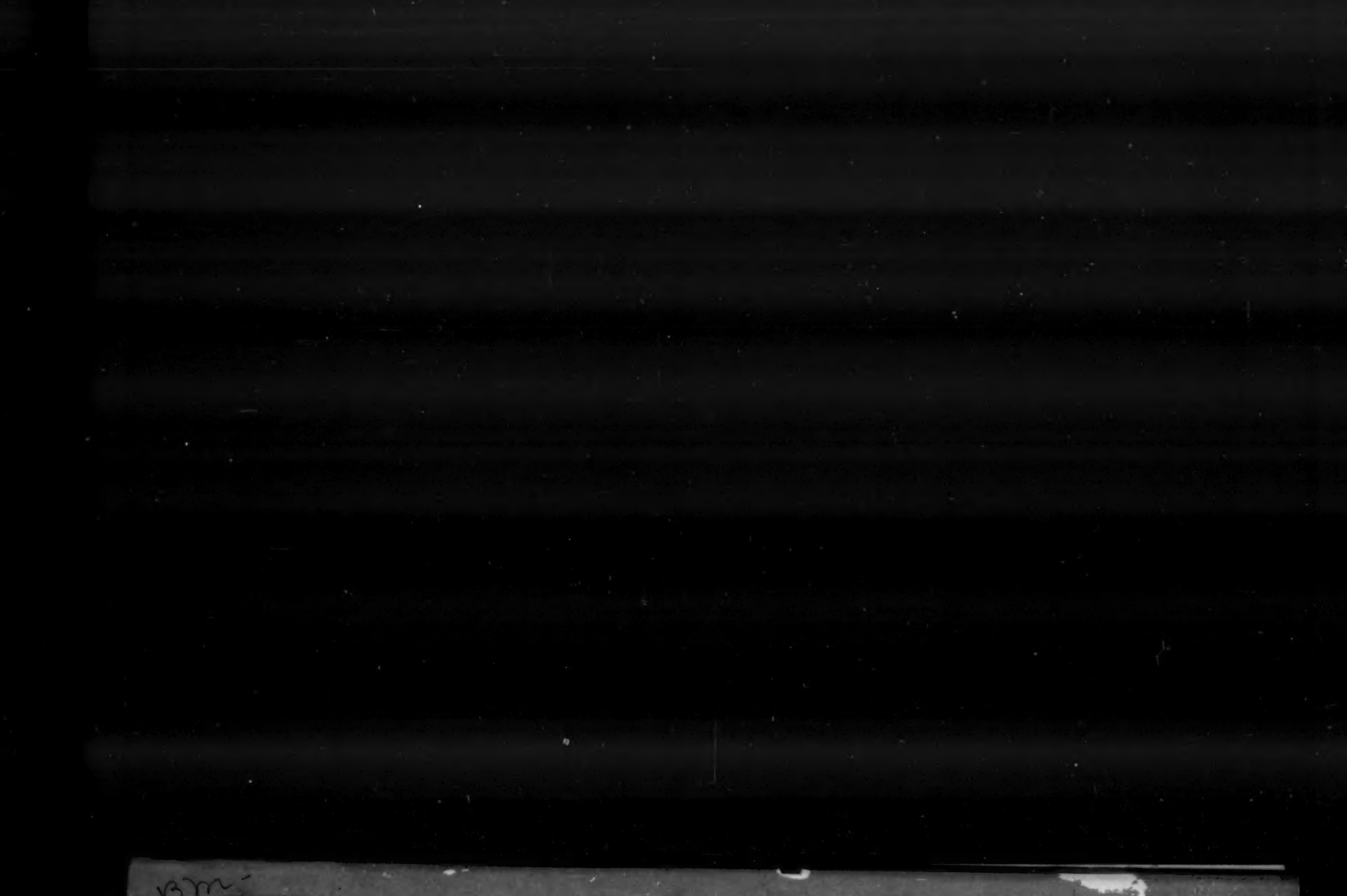
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